Financial Markets, Financial Intermediation, and Bailout Policy

Dissertation zur Erlangung
des Grades eines Doktors der Wirtschaftswissenschaften
(Doctor rerum politicarum)

der Fakultät für Wirtschafts- und Sozialwissenschaften
der Universität Heidelberg

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geboren am 16.06.1972
in Novorossiysk

Heidelberg
2006

Acknowledgements

I am deeply indebted to my supervisor Prof. Jürgen Eichberger, for his belief in me and invaluable support. My warmest words of gratitude go also to my dear teacher Prof. Revold Entov, for his involvement in my development as a scholar and as an individual. I also thank Prof. Hans Gersbach and Prof. Eva Terberger for fruitful discussions and exchange of ideas, which helped me to structure this dissertation.

A special thank I address to my colleage and coauthor Prof. Marina Doroshenko for her cooperation at all stages of my research and for her constructive criticism with regard to my research. I am grateful to Prof. Andy Mullineux for reading and commenting some of my papers, which served as a basis for this dissertation.

I thank seminar and conference participants in Heidelberg, Cambridge, Nice, Strasbourg and Helsinki for their critique and comments. Dr. John Bryan Speakman, Eckard Mauermann and Richard Jackson helped me with English formulations, thank them a lot.

The last but not the least, I thank my beloved parents, Tamara and Vladimir Vinogradovs, for their understanding and support wherever and whenever I am and whatever I plan, even if it seems unrealistic.

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Notation

The following is a list of notation, which does not pretend to be a complete list of definitions of respective variables, but rather serves as a short reference list.

a - share of deposits in the financial portfolio of a household in an intermediated economy; $(1-a)$ - share of the risk-free asset in the financial portfolio of a household in an intermediated economy (Ch. 2)

a_t - a part of the initial endowment of a consumer, which is deposited with a bank in period t (Ch. 3)

b_t - capital repayment, i.e. payoffs from an entrepreneur to workers for the use of borrowed funds in period t (Ch. 4, 5)

B_t - total capital repayments of all entrepreneurs to all workers within the period t (Ch. 4, 5)

c_t - consumption of an agent in period t (Ch. 4, 5)

c_t^{OE} - period's t consumption of the entrepreneurs who are old in that period (Ch. 4)

c_t^{OW} - period's t consumption of the workers who are old in that period (Ch. 4)

c_t^{YE} - period's t consumption of the entrepreneurs who are young in that period (Ch. 4)

c_t^{YW} - period's t consumption of the workers who are young in that period (Ch. 4)

d_{t+1} - aggregate deficit in the economy (Ch. 5)

d_{t+1}^{W} - deficit of an indifidual creditor (worker) (Ch. 5)

$d_t^{\mathrm{s}_t}$ - state-contingent deficit in a bank: the difference between the yields from investment and the payoffs to depositors in period t in state of nature s_t, $\mathrm{s}_t \in \{H, L\}$ (Ch. 3)

D - amount of deposits (Ch. 1, 2)

$\overline{D}$ - upper bound for the amount of deposits (Ch. 2)

D^d - demand for deposits (Ch. 2);

D_t^d - aggregate demand for deposits in period t (Ch.3)

D_c^d - aggregate demand for deposits in a competitive banking sector (Ch. 2)

D^s - supply of deposits (Ch. 2);

D_t^s - aggregate supply of deposits in period t (Ch.3)

D^* - equilibrium amount of deposits in the intermediated economy (Ch. 2)

e_t - wage expenditures of an individual entrepreneur in period t (Ch. 5)

E_t^e - expected profit of an entrepreneur in period t (Ch. 3, 4, 5)

$E_t^{\mathbf{s}_t}$ - state-contingent profit of an entrepreneur in the state of nature $\mathbf{s}_t \in \{H, L\}$ in period t (Ch. 3, 4, 5)

$\mathbf{E}\left(w_{t+1} | \Omega_t\right)$ - expectation of w_{t+1} conditional on Ω_t (Ch. 4)

f - production function (Ch. 4, 5)

G^e - expected payoff (gains) to a household (Ch. 2)

G_t^e - expected payoff (gains) to a consumer in period t (Ch. 3)

$G^{\mathbf{s}}$ - state-contingent payoff to a household in state of nature $\mathbf{s} \in \{H, L\}$ (Ch. 2)

i - index for an agent (Ch. 2, 3)

I_t - external finance obtained by an entrepreneur in the form of credit in period t and used to acquire capital k_{t+1} (Ch. 4)

k_t - units of good invested in the production during period t (Ch. 3); units of capital used in the production f in period t (Ch. 4, 5)

$\overline{k}$ - steady state level of k_t before the shock occurs (Ch. 5)

l_t - units of labor used in the production f in period t (Ch. 4, 5)

$\overline{l}$ - steady state level of l_t before the shock occurs (Ch. 5)

m - natural number, used in indexing periods after the shock (Ch. 5)

$\overline{M}$ - stock of liquid funds available to the Regulator (Ch.5)

M_t - the size of the liquidity injection by the Regulator in period t (Ch. 5)

$\mathcal{M}\left(\mathfrak{s}_t\right)$ - space of probability distributions over the value of the signal in the period t (Ch. 4)

n - natural number, used in indexing periods after the shock (Ch. 5)

n_g - growth rate of the population size in the model of Diamond (1965) (Ch. 4)

N_t - size of the population in the model of Diamond (1965) (Ch. 4)

p - probability of the state of nature "H"; $(1-p)$ - probability of the state of nature "L" (Ch. 2, 3, 5)

q_t - shock parameter, determines the degree of the shock in period t (Ch. 5)

$\overline{q}$ - threshold value of the shock parameter, which distinguishes between the small shock and the middle-sized one (Ch. 5)

$\underline{q}$ - threshold value of the shock parameter, which distinguishes between the middle-sized shock and the severe one (Ch. 5)

r_t - rate of interest, existing on one-period loans from period t to period $t+1$ (Ch. 4)

$\overline{r}$ - steady state level of r_t before the shock occurs (Ch. 5)

r_t^C - rate of return on credit of the period $t-1$, which is repaid in period t (Ch. 5)

r^D - rate of return on deposits (Ch. 2)

r_t^D - rate of return on deposits of the period $t-1$, which is repaid in period t (Ch. 3, 5)

r_c^D - equilibrium deposit rate of return in a competitive banking sector (Ch. 2); $r_{c,t}^D$ - the same in period t (Ch. 3)

r_m^D - equilibrium deposit rate of return in a monopolistic banking sector (Ch. 2); $r_{m,t}^D$ - the same in period t (Ch. 3)

r^{Dreg} - deposit rate ceiling

r^F - rate of return on risk-free investment (Ch. 2); r_t^F - the same in period t (Ch. 3)

r^H - rate of return on risky investment in state of nature "H" (Ch. 2); r_t^H - the same in period t (Ch. 3, 5)

r^L - rate of return on risky investment in state of nature "L" (Ch. 2); r_t^L - the same in period t (Ch. 3, 5)

r^M - rate of interest at which the liquidity assistance is available to financial institutions in distress (Ch. 5)

r^{s} - state contingent rate of return on risky asset in state of nature $\mathrm{s} \in \{H, L\}$ (Ch. 2)

$\widetilde{r}^{\mathrm{s}}$ - state contingent rate of return on bank's portfolio in the state of nature $\mathrm{s} \in \{H, L\}$; the rate of return which depositors face in case of the liquidation of the bank (Ch. 2)

$\widetilde{r}_t^{\mathrm{s}_t}$ - state contingent rate of return on bank's portfolio in state of nature s_t in period t;

$\mathrm{s}_t \in \{H, L\}$ (Ch. 3)

rr - reserve ratio (Ch. 1)

s - index denoting the state of nature $\mathrm{s} \in \{H, L\}$ (Ch. 2); s_t - the same in period t (Ch. 3)

s_t^E - savings of entrepreneurs of generation t made in period t (Ch. 4, 5)

$\overline{s}^E$ - steady state level of s_t^E before the shock occurs (Ch. 5)

s_t^W - savings of workers of generation t made in period t (Ch. 4, 5)

s_t^{OE} - savings of the entrepreneurs who are old in period t (Ch. 4)

s_t^{OW} - savings of the workers who are old in period t (Ch. 4)

$\mathfrak{s}_t$ - a signal in period t, which serves as a basis for the formation of expectations for the period $t+1$ (Ch. 4)

$\mathfrak{S}_t$ - set of all signals $\mathfrak{s}_t$ available in period t (Ch. 4)

t - time index, the number of the period starting in the time moment t (Ch. 3, 4, 5)

$u(c_t, c_{t+1})$ - intertemporal utility function (Ch. 4, 5)

V^{s} - value of the bank, i.e. value of the bank's financial portfolio in the state of nature $\mathrm{s} \in \{H, L\}$ (Ch. 2)

w_t - wage rate paid to workers of period t (Ch. 4)

$\overline{w}$ - steady state level of w_t before the shock occurs (Ch. 5)

w_t^e - wage rate expected to exist in period t (Ch. 4)

$\widehat{w}_t$ - actual wage repayment to workers of generation t after the shock (Ch. 5)

x - share of the risky asset in a financial portfolio of a creditor (either a household in a market economy, or a bank in the intermediated economy); $(1-x)$ - share of the risk-free asset (Ch. 2)

X - aggregate demand for the risky asset (Ch. 2)

X^* - equilibrium investment in the risky asset (Ch. 2)

x_t - share of the risky asset in a financial portfolio of a bank in period t (Ch. 3)

x_t^d - entrepreneur's demand for external funds in period t (Ch. 3)

X_t^d - aggregate entrepreneurs' demand for external funds in period t; equilvalently, the aggregate supply of the risky asset (Ch. 3)

x_t^s - supply of funds from a consumer to entrepreneurs for investing in the risky technology in period t (Ch. 3)

X_t^s - aggregate supply of funds from consumers to entrepreneurs for investing in the risky technology in period t; equivalently, the aggregate demand for the risky asset (Ch. 3)

y_t - amount invested by an entrepreneur into the risky technology in period t (Ch. 3)

Y_t - aggregate output in period t (Ch. 4)

z - complement to the probability of liquidation $(1 - z)$; z is the probability of bailout (Ch. 2) or the probability of "no liquidation" in case of regulatory forbearance (Ch. 3); $(1 - z)$ - the probability of liquidation of an insolvent bank (Ch. 2, 3)

γ_t - proportional fee entrepreneurs charge from consumers for the access to the production technology (Ch.3)

δ^{s} - state-contingent dividend payment to shareholders of a bank in the state of nature $\mathrm{s} \in \{H, L\}$ (Ch. 2)

Δ_t^M - period's t social losses induced by the shock in the market economy (Ch. 5)

Δ_t^I - period's t social losses induced by the shock in the intermediated economy (Ch. 5)

ε - infinitesimal increment, determines the probability of the shock (Ch. 3, 5)

η - share of workers in each generation (Ch. 4, 5)

θ^{s} - taxes collected to subsidize insolvent banks in the state of nature $\mathrm{s} \in \{H, L\}$ (Ch. 2)

ξ_t - weight coefficients in the social losses function Ξ (Ch. 5)

Ξ - social losses function (Ch. 5)

Π^e - objective function of a bank: expected profit of the bank or of the bank's shareholders (Ch. 2); Π_t^e - the same in period t (Ch. 3)

Π^{s} - state contingent profit of the bank in the state of nature s (Ch. 2)

ρ - probability of the event that depositors are repaid in full (Ch. 2, 3)

τ - time-index used to denote the shock period (Ch. 5)

$\Phi(w_t, d_t)$ - dynamic map $(w_t, d_t) \to (w_{t+1}, d_{t+1})$ (Ch.5)

Φ_0 - dynamic map Φ for the system with zero deficits (Ch.5)

$\psi(\mathfrak{s}_t)$ - expectations function (Ch. 4)

$\Psi(I_t, \mathrm{s}_{t+1})$ - state-contingent production function with the production factor I_t and the output in the period $t+1$ depending on the state of nature s_{t+1} (Ch.3)

Ω_t - set of information and techniques available in period t to form expectations for the period $t+1$ (Ch. 4)

Introduction

The 1980s and 1990s have been marked with a series of financial and banking crises all over the world. This turned the attention of economists to such questions as how a financial system should be structured in order to reduce the vulnerability of an economy to the risk of a crisis, or what policy should regulators follow in order to prevent the crises, and what regulatory measures would help in reduction of harmful effects of the crises? Two puzzling practices may be observed in the policy of banking regulators. First, it is a policy of "constructive ambiguity", which allows some (but not all) failing banks to have access to the rescue packages. Secondly, it is regulatory forbearance, which allows insolvent banks to operate further, as though they were solvent. Both practices are often criticized, but still regulators in many countries follow them. The theory suggests some explanations to such policies, and in this dissertation I will also pay them a lot of attention.

The objective of this dissertation is to study relative advantages of a bank-based financial system against a market-based one. Instead of considering the role of financial intermediaries and financial markets in promoting economic growth, I focus on their ability to handle a crisis situation. The design of the bailout policy plays an important role in this issue, therefore I start the analysis with a microeconomic discussion of insolvency resolutions and then proceed to a macroeconomic discussion of an optimal crisis management.

The literature on banking theory and regulation is huge, but far from exhaustive. I give a survey of the literature in Chapter 1. I start the literature review with contributions of banking theorists of the XIXth century and study the development of this field of economics over the XXth century to the modern banking theory. Not surprisingly, the issues in the focus of researchers have not changed over the time, and the core question is the one with regard to better provisions for financial and general economic stability. Modern banking theory studies banks (and financial intermediation in general) from several perspectives, including but not limited to microeconomc foundations of the co-existence of banks and financial markets, the macroeconomic role of financial intermediaries, the interdependence of financial, currency, debt and other types of crises and the role financial intermediaries play in them, and the the optimal design of the government policy and the regulation of financial systems. Chapter 1 provides an overview of the spectrum of research in the theory of financial intermediation.

Despite great interest of economists in these and related topics, there is still no consensus regarding the bailout policy. The researchers divide themselves into "interventionists" and "non-interventionists", with the former arguing for the necessity to rescue the banks, and the latter insisting that the failing insitutions should be liquidated. One of the common arguments of the "non-interventionists" is that the developped financial markets can replace financial intermediation and provide an economy with more efficiency in funds channelling.

This comparison of intermediation versus markets has become another basin of attraction for economic research. In this dissertation, I compare an intermediated system with a market-based one at each step of the analysis. In Chapter 2, I present a relatively simple static partial equilibrium model to study the effects of the regulator's choice regading insolvency resolutions on the ability of the banking system to provide the same allocation of funds as the market economy does. This allows one to come to a conclusion about the optimality of the choice between two options: liquidation of insolvent banks or bailout through subsidization. I use this simple framework to examine the optimality of "constructive ambiguity" and discuss, how ambiguous may the bailout policy be.

"Constructive ambiguity" may be studied in a static setting, but forbearance is a kind of regulatory policy, which may only be studied in a dynamic context. In Chapter 3, the static model of Chapter 2 is extended into a dynamic framework to study the effects of regulatory forbearance. In contrast to liquidation or bailout through subsidization, forbearance destroys limited liability of banks and make them internalizing the costs of failure, which is of a special importance if the competition in the banking sector is intense. At the same time, forbearance may eliminate the internalization of bailout/liquidation costs by depositors, and this effect of forbearance further contributes to the efficiency of intermediation. I discuss the issues of limited and unlimited liability, of uncertainty and ambiguity with regard to the regulatory measures, and of the efficiency of forbearance policy in Chapter 3. I also present a general equilibrium interpretation of the model inherited from Chapter 2.

The concept of equilibrium is developed further in Chapter 4, where a general equilibrium model with overlapping generations is discussed. The dynamic macroeconomic environment (through overlapping generations setting) enables evolutionary analysis, which is important when the development of the banking (or general financial) crisis is considered. In Chapter 4, I study the existence and uniqueness of the equilibrium. In order to compare the abilities of the market-based economy and the intermediated one in handling the crisis, it is important to establish, whether the two are dynamically equivalent. I study the issue of stability of the stationary steady state and compare the development of the two economies from an arbitrarily chosen initial condition to the steady state equilibrium. This allows one to examine the dynamic equivalence.

Chapter 5 concerns with the crisis issues. The crisis in the model is triggered through an exogenous macroeconomic shock, which may be, for example, a negative production shock. I remove any uncertainty from the model in order to focus on the effects beyond moral hazard. The macroeconomic shock is effectively unanticipated, and this suffices to generate differences in the two worlds (one with financial intermediation and one without it) even in absence of agency problems. The general equilibrium approach allows one to study the differences in the evolution of the intermediated and the market economy after such a shock. An important message of this chapter is that although an announcement of bailout incentives (or introduction of the state guarantees on deposits) prevents bank runs, it is not sufficient to provide a recovery of the banking system after the shock, and further regulatory interventions are needed. Two types of interventions, namely liquidity assistance and deposit rate ceiling, may be implemented by a regulatory body in the model. I do not introduce any deposit insurer explicitly into the model. Firstly, it suffices if depositors believe they would be repaid in full, which may also be achieved within a bailout policy with the Lender of Last Resort . Secondly, many countries, which experienced shocks, had no explicit deposit insurance schemes.

Finally, in Chapter 6, I consider the example of Russian default in August 1998. Russian financial system as of 1998 suits the model relatively well: (1) the role of financial markets is negligeable, (2) banking sector is rather homogenous, (3) the default of the government was a triggering shock for the crisis, and (4) there was no explicit deposit insurance. I compare the development of events with those predicted by the model. To complement the picture, I compare the theoretical results with the actual data on financial crises in two other countries: Japan and Sweden. The three crises considered were very different and provide a good illustration for the applicability of the model.

Although the dissertation focuses mainly on the bailout policy and crisis processing, I also discuss here other relevant issues, such as a need for a complementary policy and an institutional design of a financial system. The latter issue is of the great relevance for transitory countries and emerging economies, many of which still have an option to decide whether their financial system should be built as a market-based or as a bank-based one. I briefly summarize and discuss the results in the Conclusion.

Chapter 1
The Theory of Banking and Bank Regulation: brief history of thought

This chapter presents a brief overview of the banking theory with a particular emphasis on the regulatory issues. In this chapter, I discuss some important assumptions relevant for the modelling in the subsequent chapters. The chapter also establishes links between the existing literature and this dissertation and places the research in this dissertation into a broader context of the theory of financial intermediation.

1.1 The Theory of Banking and Financial Intermediation

Financial intermediaries and financial markets are two important institutions, which contribute to the optimal allocation of resources in an economy. Although both financial markets and financial intermediaries have existed over centuries, economists did not regard them to be important until 1960s. As Eichberger (1998) points out:

> *"[In the sixties] the study of financial institutions was a litle known field of economics, and the role of financial intermediation was poorly understood. In a world of frictionless markets in which prices move in order to equate demand and supply simultaneously in present and future markets, there is no need for payments and credits, nor for savings and investment. Financial institutions... were seen as means for implementing this ideal of markets, possibly absorbing minor real-world frictions of the*

system." (p.1)

Assets are promises to deliver goods or money on a specified date under specified conditions and can be traded like goods and services in markets. One refers to such markets as financial markets. Ideally, financial markets could provide for all flows of funds between economic agents.

In practice, the organization of financial markets can face difficulties. For example, asymmetric information or transaction costs can make it impossible to organize an ideal system of financial markets. In such cases, a financial intermediary can partially fill the gap in the financial system and improve the flow of funds between economic agents.

There are many types of financial intermediaries (see the modern definition of financial intermediaries in Section **??** below). Benston and Smith (1976) distinguish between several forms of intermediation, and even refer to market places (stock exchanges), dealers and brokers as intermediaries. Nonetheless, they emphasize that the theory mainly deals with a more complex form of financial intermediation, which "... is one in which new financial commodities are produced. This form of financial intermediary is exemplified by mutual funds, banks, and consumer finance companies."

The theory of financial intermediation pays much attention to banks. For example, Gorton and Winton (2003) devote most of their review of the theory to banking models. In many countries (e.g. in Germany, France and other european countries), it would be hard to distinguish between banks and other types of intermediaries, since banks offer insurance, investment, brokerage and other services in addition to their deposit and credit functions. In other countries (e.g. U.S.), legislative barriers exist which inhibit banks from exercising non-typical banking activities, and the broader term "financial intermediation" is used to describe financial institutions as a whole.

Statistical support also emphasizes the importance of banks. Mayer (1990) finds that in the period from 1970 to 1985 bank loans were the predominant source of external funding in OECD countries. According to the European Central Bank (ECB, 2006) the predominant source of finance for the European non-financial sector (including government) are loans from European monetary financial institutions (MFIs): 8,103.4 billion EUR out of a total of 18,636 billion EUR in liabilities (compared to 3,240.5 billion EUR in shares and 667.7

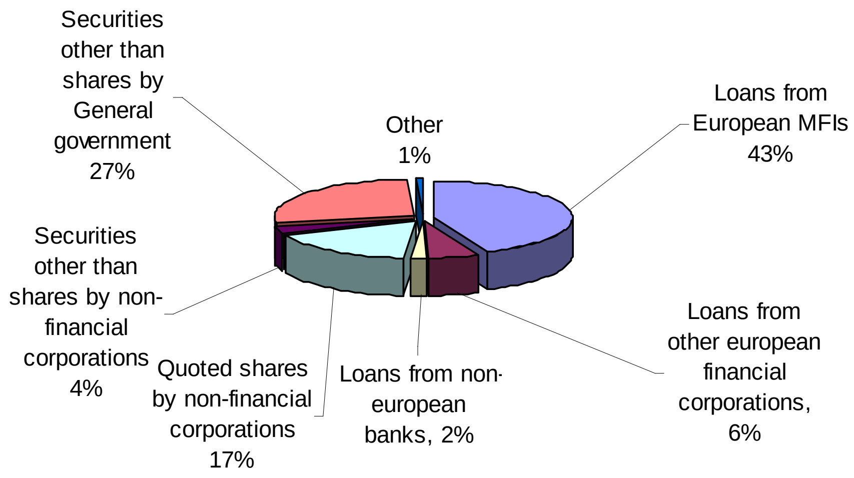

Figure 1.1. The structure of liabilities of european non-financial sector as of June 30, 2005. *Source*: ECB (2006)

billion EUR in other securities issued by non-financial corporations; all figures as of June 30, 2005). A more detailed picture of the financial sources in Europe is given in Fig. **??**.

Bond (2004) presents a framework in which he examines why banks and nonbank financial intermediaries continuously coexist. This issue is not within the scope of this dissertation. I consider banks as the only [generalized] form of financial intermediation. Moreover, I assume that banks perform only two types of activities, namely they acquire deposits and grant credits.

Another important element of the system of financial intermediaries is a regulatory authority. Three pillars of the regulation exist in the literature on financial intermediation: (1) structural regulation, (2) insurance regulation, and (3) prudential regulation. Structural regulation deals with the competitive environment between different types of intermediaries as well as between intermediaries of one type. Insurance regulation deals with deposit insurance schemes and with insolvency resolutions. Prudential regulation imposes a system of administrative standards with regard to capital adequacy, depreciation rules, accountability etc., in order to guarantee or determine the soundness of financial intermediaries.

In this dissertation I consider a regulator that primarily plays the role of the Lender of Last Resort, which is a part of insurance regulation. As an additional regulatory measure, I will also consider the regulation of interest rates, which actually belongs to the structural regulation pillar. A discussion of the current regulation practices can be found in Dewatripont and Tirole (1994). For a discussion of the Lender of Last Resort see Goodhart and Illing (2002).

The aim of this chapter is not to exhaustively present the contemporary theory of banking and financial intermediation, but rather to briefly review the development of the banking theory. Solid surveys of the modern theory can be found in Bhattacharya and Thakor (1993), Freixas and Rochet (1997), as well as Gorton and Winton (2003). For a comprehensive discussion of the current state and perspectives of the theory of financial intermediation see Allen, Santomero (1997, 2001) and Scholtens and Wensveen (2000, 2003).

Instead of reviewing only recent contributions to the theory of banking and financial intermediation, I present a brief summary of its history. This seems to be especially relevant if one notes that the names of banking theorists of the 19th century like Thornton and Bagehot repeatedly appear in the contemporary literature and their ideas have experienced a revival in the last years. As previously stated, this summary neither purports to be detailed nor complete, but rather focuses on the developmental highlights of the last two centuries.

1.2 The Origins of Banking Theory

The interest (and especially theoretical interest) in banking rose during the 19th century along with the strengthening of the central banks. Though the first central banks (Sweden, 1668, and England, 1694) had been established two hundred years earlier, the actual power of central banking first became visible in 19th century. Since the first governmental (or royal) banks were competitors of the private banks (e.g. in England, France, particularly unsuccessfully[1] in USA etc.), the position of the private banks in the market seemed to deteriorate,

[1] The first bank with central banking powers in the United States was the Bank of North America (chartered 1781). It was chartered as the First Bank of the United States in 1791. It was modelled after the Bank of England. However, there was a strong pressure against the First Bank from both the farming community as the clientel and other private banks as competitors, which resulted in the loss of the Bank's charter in 1811. The liquidation of the First Bank stimulated the development of the banking sector and the issuance of bank notes by private banks, which lead to high inflation and instability in 1815. In 1816, the Second Bank of the United States was chartered, but again faced a strong political opposition, and was closed in 1836. The "era of free banking" from 1836 to 1913 was marked with significant banking panics and financial crises, which illustrated the desirability of an institution like a central bank. In order to prevent the negative reaction of the strongly regionalized society, such institution was created in 1913 on the basis of twelve regional banks, which constituted the Federal Reserve System.
The history of central banking is not the focus of this dissertation. The historical episodes, which I mention

which may explain the rise in sophisticated books devoted to banking.

The 19th century offers many works devoted to banking, so by its end many authors presented the "theory of banking" (e.g. Easton, 1900; Macleod,1892; Courcelle-Seneuil, 1909). The basic elements of this theory are presented below.

1.2.1 Banks as Trading Institutions

The framework of analysis of the early banking theorists was mostly limited to the description of banking operations and the potential influence of external factors, to which banks were assumed to be able to react properly. The economic theory of that time regarded banks as institutions that traded money, and treated money as one of the goods, commonly accepted as a unit of account (*numéraire*), and as means of payment and of saving. In other words, since money was considered to be just a type of good, other monetary institutions than central banks had to be understood as shops trading with these goods:

> *"La Banque est la maison de commerce oú l'on vend et achète des valeurs de commerce, titres de rente d'Etat et hypothécaires, actions, monnais, matières d'or et d'argent, etc." (Courcelle-Seneuil, 1852, quot. 1909)*[2]
>
> *„A Banker is a Trader who buys Money, or Money and Debts by creating other Debts" (Macleod, 1892, 1899)*

In accordance with these definitions, the first "theories of banking" were mostly a collection of practical recommendations on how to run a bank. At the same time, the early theorists of banking did recognize a certain difference between banking business and ordinary trading business. The essence of this difference is the risk in the banking business.

1.2.2 Banking Risks

One of the principal problems a banker faces, is the risk of banking operations. The issue of risk is extensively discussed in the early literature on banking. Two primary types of risks can be distinguished in this context: liquidity risk and portfolio risk.

Liquidity risk arises from the obligation of a banker to pay any depositor off entirely on

here, are considered in Doroshenko and Vinogradov (2006, Ch. 11). For a review of the literature and for a discussion of the history of central banking see e.g. Epstein (2005).

2 "A bank is the house of trade, in which commercial papers, state financial obligations, mortgages, shares, monies, pieces of gold and silver etc. are bought and sold" (transl. D.V.)

demand. Certainly, it is only possible if the banker holds the funds in cash. However, to make the business profitable, the banker has to invest, which in the 19th century meant to buy and hold securities, bills, monies, precious metals etc.[3] In order to turn some objects of investment back into cash, the banker requires both time and effort, because the assets do not possess the ultimate liquidity of cash. The banker faces the danger of inability to pay his obligations. Although early banking theorists did not explicitly call this danger "liquidity risk", they still contributed significantly to the development of the theory of the banking liquidity.

Otto Hübner (1854) suggested the **Golden Rule of Banking** (*die Goldene Bankregel*), which solves the problem of liquidity risk through matching the maturities of debts:

> *"Der Kredit, welchen eine Bank geben kann, ohne Gefahr zu laufen, ihre Verbindlichkeiten nicht erfüllen zu können, muß nicht nur im Betrage, sondern auch in der Qualität (d.h. in der Laufzeit) dem Kredit entsprechen, welchen sie genießt"*[4]

The Golden Rule of Banking does not allow for any mismatch between the maturities of assets and liabilities. If a debt is to be paid off, there should always exist a credit in the same amount, which has to paid on the same day. Theoretically, this should eliminate liquidity risk, but only under the assumption that all debts (both on assets and on liabilities sides) are duly paid, i.e. without delay or default.

Adolf Wagner (1857) modified the Golden Rule of Banking into the "**Theory of Sediment**" (*Bodensatztheorie*), which suggests a possibility of a mismatch between the maturities of assets and liabilities. The transformation of maturities is based upon two principles: prolongation and substitution. First, the deposits can be repeatedly extended without being withdrawn. Secondly, current withdrawals can be [partially] covered (substituted) by the newly made deposits. These two features of the depositors' behavior enable the a long-term "sediment" in the bank. The sediment in this context is the amount of free funds, which can be used for the long-term investment. Although the liabilities of the bank still have a shorter

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3 Nowadays the list of investment activities of banks is much larger and includes not only "buy and hold" activities, which can include controlling businesses within a holding structure, but also speculative purchases and short sales of securities as well as operations with derivatives.

4 "The credit, which can be granted by a bank without facing the risk of not being able to fulfill its obligations, must correspond to the credit, which the bank obtains, not only in the amount, but as well in the quality (maturity)" (transl. D.V.)

maturity, the liquidity risk is relatively small due to the prolongation and substitution.

Nonehteleless, Wagner focused on banks' liquidity risk, implicitly assuming no defaults on the assets, which is hardly to be expected in practice. This observation led Wilson (1879) to another vision of a safe bank:

> *"Banks all live and work on the assumed condition of being able to pay every deposit and other creditor in full, when called upon to do so; and that condition imperatively demands that banks shall not lock up the money entrusted to them where it cannot be found when wanted. In actual business practice this is, of course, an impossible condition taken in its absolute sense, and therefore actual banking credit rests on a well-understood compromise. A kind of undefined law of averages prevails, whose dictates are, that in order to be practically safe a bank must carefully subdivide its risks". (p.63)*

The need to subdivide risks (portfolio diversification) is the second essential conclusion of the early theorists of banking. However, there is not much to be found in the early banking theory regarding the specific portfolio risk, in contrast to the liquidity risk, which seems to be largely studied. Important questions still remain: *what* is the "undefined law of averages", *why* does the subdivision of risks lead to less risky banking, and *how safe* is a "practically safe" bank? Although these questions were first answered with the development of the portfolio theory, first attempts to study the probabilistic nature of banking were already made within the early banking theory. Edgeworth (1888) was one of the first scholars to apply the theory of probabilities to the study of banking stability.

1.2.3 Banking and Reserves

Edgeworth (1888) introduced mathematical methods (probability approach) to the banking theory. Edgeworth starts his paper with the remark:

> *"Probability is the foundation of banking. The solvency and profits of the banker depend upon the probability that he will not be called upon to meet at once more than a certain amount of his liabilities".*

The model, hence, is related to Wagner's "theory of sediment". In contrast to Wagner, however, Edgeworth does not assume that the "certain amount of liabilities", which is to be paid off, is covered by new deposits. Instead, the bank is supposed to hold some reserves, in order to be able to pay depositors on demand. Of course, reserves are the most liquid assets and should directly solve the liquidity problems of the bank, which had been already stressed by other economists, e.g. Wilson (1879):

> *"In judging of the soundness or otherwise of a bank, we have first of all to consider what proportion its most available assets bear to the liabilities. These assets are the cash and the trade bills discounted – the actual money, and the security most easily convertible into money immediately and without loss, or which is always in the ordinary course of business converting itself." (p.32-33)*

Edgeworth's model consists of a bank that issues notes (an analogue for today's deposits), and customers who hold these notes (an analogue for today's depositors). Applying then the methods of probability theory, Edgeworth shows that the amount of reserves the bank holds against deposit withdrawals, should be proportional not to the amount of the total liabilities, but rather to the square root of that amount. Edgeworth tests this hypothesis using data from the Bank of England. The choice of the Bank of England may appear odd nowadays, but in Edgeworth's times it primarily acted as a common private bank, as confirmed by Bagehot (1873):

> *"... the distinct teaching of our highest authorities has often been that no public duty of any kind is imposed on the Banking Department of the Bank; that, for banking purposes, it is only a joint-stock bank like any other bank; that its managers should look only to the interest of the proprietors and their dividend; that they are to manage as the London and Westminster Bank or the Union Bank manages."(p.154)*

Edgeworth does not call his theoretical conclusion a new rule for banking: "[The writer] does not pretend to base any practical recommendations upon the theory." Still, Edgeworth suggests there is a need for coordination among banks, since this would allow them to decrease the average rate of reserves:

> *"... if n banks become coordinated by keeping their reserve in one prime bank, the reserve which is now required to keep their liabilities tends to be less than n times the previous average reserve"*

Indeed, if the total amount of liabilities of all n banks is denoted with L, and the amount of reserves with R, then under the assumption of reserves being proportional to the square root of the liabilities, the reserve rate should constitute $rr = \frac{R}{L} = \frac{\alpha\sqrt{L}}{L}$. With a sufficiently large number of banks, their total liabilities L would be large enough to make the rate of reserves rr significantly small. This conclusion could explain why the contemporary reserve rates set by central banks are so small. The amount of total reserves may even be smaller than the square root of the total liabilities, since payments from one bank are payments to another and cancellations may then be substituted for cash payments. This conclusion is similar to the substitution principle in the theory of Wagner, but in Edgeworth's model, the substitution takes place not at the customers' level, but rather between banks themselves.

1.2.4 Banking and Government Policy

As Edgeworth's analysis indicates, there is a need for coordination among banks. This may legitimize a possible banking regulation in a form of a centralized reserve system. The system of reserves would help against liquidity risk, but is not a panacea against the possible insolvency of the banks due to defaults on banks' credits. Moreover, the idea of a centralized reserve system is based upon the probabilistic assumption regarding the frequency of withdrawals, which depends on the behavior of depositors. In times of panic, such system of reserves would not help.

Walter Bagehot (1873) claimed that it is the duty of the central bank (Bank of England in the work of Bagehot) to support the banks in times of panic. In contrast to the idea of reserves, studied by Edgeworth, Bagehot stressed the importance of lending from some authority, which would improve the liquidity of banks in times of panics. Based on this belief, Bagehot's work is often referred to as the study of the need for a **Lender of Last Resort**. Although the Bank of England usually supplied the market with funds in cases of panic, there was no rule or legislation, which obliged it to do so. Bagehot insisted that the introduction of such rules would eliminate needless uncertainty:

> *"The public is never sure what policy would be adopted at the most important moment: it is not sure what amount of advance will be made. The best palliative to a panic is a confidence in the adequate amount of the Bank reserve, and in the efficient use of that reserve."(p.196)*

The study of possible banking reforms necessary to prevent such crises is developed by Wilson (1879). The first chapter in his book is heavily based on a paper written one year previously, in which he analyzed the balance sheets of banks and concluded that a banking crisis was possible and immanent; the crisis indeed appeared at the time of the book's publishing. Wilson's book provides a sophisticated survey of banking operations with a special emphasis on the dangers they can provoke. This allows Wilson to formulate the measures necessary to avoid future crises in the banking sector.

The first (chronologically speaking) possible measure in a sequence of reforms Wilson suggests in connection with the prevention of banking crises, concerns changes in the legislative system:

> *"When we directly approach the subject of reform ... the startling fact confronts us that our much belanded banking institutions exist in a state of chaos. There is literally and truly no well-defined banking law in the country, still less any well-defined banking habits." (p.68)*

The second transformation in the banking sector proposed by Wilson (which, of course, requires special judicial acts as well, but is distinct from the legislative determinism) relates to informational asymmetry:

> *"[The banking reform should] introduce greater frequency, uniformity and fullness in the published balance sheets." (p.43)*
>
> *"There are two practical banking reforms absolutely wanted... The one is the audit of bank accounts by independent authorities outside the directorate or the copartnery, and the other is the periodical publication of banking balance-sheets properly certified by the auditors." (p.77)*
>
> *"Bank directors or managers are not in the nature of things to be trusted to audit their own accounts and it is monstrous that they should make the claim to do so. [...] What is really desired is not an inquisition into bank's affairs, but a check on fraud... " (pp.82, 84)*

The three principal issues studied in the early banking theory with regard to the government policy can be summarized as (1) the bailout policy, (2) legislative determinism, and (3) information disclosure.[5] All three concern the stability of the banking sector, which was the banking theorists' primary concern.

It should be noted that banks were also paid great attention in other fields of economics,

[5] A careful reader can also find passages in Wilson's work devoted to capital adequacy, excessively large banks, and the advantages of a banking system consisting of a larger number of smaller banks compared to a system with less competition. I do not refer to them here since the author places them into another context.

particularly in macroeconomics. Harris (1981, Ch. 6) relates the general interest towards banks to the changes in the society, which took place in 18th and 19th centuries. The development of the banking system made the consideration of the role of banks unavoidable in the analysis of the general economic activity. Especially neo-classical theorists recognized that the banking system was one of the economy's core elements, which explained the interdependence between money, prices and interest rates. Mill (1848) wrote:

> *"It is perfectly true that... an addition to the currency almost always seems to have the effect of lowering the rate of interest; because it is almost always accompanied by something which really does have that tendency." (p. 431)*

According to Mill, this "something" are bank loans, and although currency issues cannot influence the rate of interest as currency, they can do so in the form of loans. Wicksell (1898) introduced a "money interest rate" as determined by the banks' loans in contrast to the "natural rate" as determined by the real profit rate given by the actual productive investment. The conception of banks as money makers (opposite to the view of them as money traders as discussed above) extended in the macroeconomic literature in 1920-30s (see e.g. Robertson, 1922 and 1926). However, these studies still viewed banks as passive conduits of monetary policy. In this sense, they hardly can be attributed to the theory of banking. Moreover, even a brief discussion of the history of macroeconomic thought would go far beyond the framework of this chapter.

1.2.5 The Need for a New Approach

Early banking theorists developed and elaborated upon many proposals regarding reforms in the banking sector in order to reduce the risks in banking. However, these suggestions were not adopted. Bagehot insisted that the larger reserve would be needed to support the role of the Lender of Last Resort, but the reserve ratio remained unchanged. Wood (2003) indicates that the suggestions to reform the banking sector in England were repeatedly declined by politicians.[6] In the U.S., the Federal Reserve system was founded only in 1913, after two

[6] Wood (2003) writes: "Parliament and the Bank of England did not take up the explicit contingency plan proposed by Bosanquet, the House of Lords committee, Bagehot and Lowe until the 1920s." Henry Bosanquet, the London and Westminster Bank, suggested the rule, according to which the Bank of England should credit other banks as soon as the interest rate rises above 8%. The House of Lords committee insisted the Bank should abandon the "currency rule", which tied its notes to its gold reserves, since in times when the reserves decrease,

previous attempts to create a regulatory banking authority failed during the 19th century.

Asides from political disinterest in reform proposals, there was not much theoretical progress in the theory of banking either. The practical view of banking dominated research aspects until the second half of the 20th century. In 1931 Knies suggests the "shiftability theory", which argues that liquidity in the market can also be increased in the short run, if an appropriate liquidity premium is paid (Knies, 1931). In 1959 Wolfgang Stützel considers bank runs to show that the "sediment" suggested by Wagner can converge to zero, and the bank would be forced to sell its assets. This urgent sale of the assets can result in their decreasing value, which presents an additional burden for the bank. In order to reduce this load, Stützel (1959) suggests to limit such urgent sales to the value of the bank's capital. These two studies are extremely rare examples of some development in the banking theory between 1900s and 1960s. Furthermore, these and other developments in the study of banking were significantly separated from the mainstream of economic thought.

One can – to some extend – explain the lack of the theoretical attention paid to banks when one considers the role of money at that time. Classical economists believed money was just a kind of good. Since banks dealt with money, the study of banks had to be the study of trading institutions. Neoclassical and Keynesian re-thinking of money, and particularly more broad understanding of money as both currency and deposits, did not change the situation. Though money was recognized to be able to influence general macroeconomic indicators (such as price level in the quantity theory, and partially output in the Keynesian theory) and "money-trading" banks gained new attention as "money-makers", banks still played the role of passive providers of depositing services and conduits of the monetary policy.[7]

Another possible explanation for the limited attention banks received can be seen in the domination of the market approach in the first half of the 20th century. It seems that the initial focus on banks in the 19th century was mainly due to their role as a "gate of entry" to the market of financial assets. In this sense, the study of banks to some extend substituted the study of financial markets. With the development of financial markets, the focus of study

the amount of notes should stay stable to avoid the crisis. Robert Lowe, Chancellor of the Exchequer, introduced a bill "to provide for authorizing in certain contingencies a temporary increase of the amount of Bank of England Notes issued in exchange for securities". (See Wood, 2003)

7 Remember, in the theory of money multiplier, banks are assumed to grant loans in the amount of $(1 - rr)$ times the amount of deposits, where rr is the required reserve rate. Decision-making by banks, which would explain why exactly this proportion of deposits is granted as loans, is not considered here.

in economics shifted to direct finance, and the role of intermediaries was largely neglected. As long as the theory provided suitable explanations for the fluctuations of prices, interest rates and output, there was no special need to consider intermediaries as decision-makers.

1.3 The Start of the Modern Banking Theory

The modern banking theory has undoubtedly started with the seminal contribution by Gurley and Shaw (1960). The most often cited section of their work is the definition of banks as transformers of deposit portfolio into loan (credit) portfolio (examples are Baltensperger, 1980; Dewatripont and Tirole, 1994; and innumerable others; see also a broader formulation of this definition below). However, they were not the first to define the banks in this way. Yet by the end of 19th century, banks were defined as institutions collecting deposits and issuing loans:

> *"A Banker is a merchant, dealing in capital, and in this capacity acts as a broker between two principals; ... the depositor, who leaves his capital in order to obtain interest for the same, and ... the borrower who is willing to pay a certain sum for the loan of capital (Easton, 1900)*

Moreover, as mentioned above, since Wagner (1857) it was recognized that banks could transform the maturity of the liabilities into a different maturity of the assets. The difference hence lies in the fact that since the 1960's, banks were no longer considered to be mere brokers, but rather as active players, who are not only affected by the economic environment, but also affect the economic performance themselves. Banks, as defined by Gurley and Shaw, do not just trade financial assets, but also create new assets.

Though Gurley and Shaw explicitly claim to be pioneers in the field, they base their book upon a number of results either already published or in progress at the time of their research. They state that M. Friedman, R. Goldsmith, and Ph. Cagan stimulated their work. The view of banks in this strand of literature falls into the monetarist worldview, in which money matters, and in which banks strongly influence the money supply and the function of economy. Further developments contributed to the identification of additional distinctions of financial intermediaries from markets and/or brokerage services. They are discussed below.

Modern banking theory (or, more generally, the theory of financial intermediation) primarily analyzes the functions of financial intermediation, the way the intermediation affects the economy, and the effects of the government policies on the financial intermediaries. The first approach studies the role financial intermediaries play in economies (and financial intermediaries are often reported to act as promoters of economic efficiency and growth), the second one investigates government regulation imposed upon financial intermediaries. Both approaches are closely related one to another. On the one hand, studies in the economic role of intermediation disclose internal failures of the banking industry and reveal sources of suboptimality in the promotion of economic inefficiency by financial intermediation. This dispatches the field for regulatory studies (and may therefore be called the policy-foundation research). On the other hand, studies in regulation define the circumstances in which financial intermediaries operate, and examine the possible reaction of financial intermediaries to such regulation. This identifies the issues related to the general economic effects of intermediation (and, therefore, can be considered as a policy-development research).

Research in banking theory (within both approaches) requires a clear definition of financial intermediaries. **Financial intermediaries** provide the economy with risk-return combinations for borrowing or investing capital, which are superior to those possible without intermediaries and, therefore, they augment an economy's production potential. Intermediaries achieve this by pooling capital and spreading risk. Deposits are collected from agents wishing to invest money, and these funds are subsequently made available to agents seeking capital. This broad definition of financial intermediaries based on the functions they perform follows that of Gurley and Shaw (1960). Theoretical investigations in banking outline a simple scheme describing the way intermediaries promote economic efficiency through linking savers (lenders) and producers (borrowers), and this scheme is summarized below. A very important part of the definition by Gurley and Shaw is that the banks (financial intermediaries) provide the economy with better investment opportunities than those available without banks. This active role of the intermediation was absent in the early banking theory.

For borrowers, intermediaries provide large amounts of capital at low transaction costs. For lenders, intermediaries reduce two specific types of risk: investment (portfolio) risk and liquidity risk. These are the types of risk, which had been studied by the early banking theorists. The new theory of banking considers the same types of risk, however, from the customers' perspective. The challenge for the modern banking theory is to identify whether or not a banking system can reduce a customer's investment risk and the liquidity risk, compared to those the customer would face if investing directly in a financial market. The theory of financial portfolio plays a paramount role in understanding the banks' abilities to reduce the investment risk. With regard to the liquidity risk, monetary theory suggests a vision of banks as creators of money.

1.3.1 Banks as Portfolio Managers

Portfolio diversification is the one aspect that brings the banking theory and the theory of finance closely together. Portfolio diversification by banks has been studied widely both theoretically and empirically (see e.g. Kane and Buser, 1979).

Tarazi (1996) discusses a framework to analyze a bank's activities via its portfolio composition and provides a model that demonstrates that a bank's capital and return on capital together with its relative risk-aversion measure are major factors that influence the bank's optimal decision-making with regard to its portfolio composition. The principal assumption in models of this type is that banks demonstrate risk-averse behavior. Though there may exist situations in which banks are risk-lovers (e.g. banks close to failure or with a high probability of liquidation as in Rochet, 1992; and Milne and Whalley, 1998), risk-aversion is a common assumption for models of risk in banking. One of the mechanisms that may restrain risk-taking on the part of banks is divergence of interest between managers and shareholders. O'Hara (1983) formally models this divergence, showing that the costs to managers of losing their jobs may indeed induce risk-averse behavior. Such divergence is a justification for the risk-averse bank utility function as in Kahane (1977), Koehn and Santomero (1980), and Kim and Santomero (1988).

Walker (1997) studies assets allocation in banks by applying recursive programming to bank asset management in order to simulate short run dynamic decisions. The dynamics in the model is described with difference equations representing a bank's investment activity limited by the balance sheet and regulatory constraints. The model is an indirect application of the market mediation system, in which buyers, mediators, and sellers are linked together. The dynamic framework of the model provides an opportunity to predict the changes in portfolio composition for periods of several years.

Financial innovations may dramatically influence the risk associated with asset portfolios held by banks. Santomero and Trester (1998) investigate the effect of one special change in the financial sector, namely, the growing ease, with which banks can sell the assets they have created. Two main questions arise in this context: (1) would the existence of a secondary market for banks' credits lead to an increase in the credit risk, and (2) would banks themselves become more vulnerable to instability and failure? The results obtained by Santomero and Trester (1998) suggest that such innovation unambiguously increases the share of risky assets held by the banking sector. Since the assets of banks become more liquid, the banking sector provides more capital for risky investment (which Santomero and Trester introduce as the real sector investment). At the same time, it does not necessarily imply that banks themselves become more risky, since the increased liquidity of the assets provides banks with a tool against insolvency: if a bank needs liquidity before the real sector assets mature, it can sell them at the secondary market.

Another strand of the literature on banks as portfolio managers studies macroeconomic aspects of optimal allocation of assets by banks. For example, this problem is studied in Levine (1991) and Saint-Paul (1992) within the investigations in economic development.

1.3.2 Banks as the Core of the Payment System

The monetarist approach in macroeconomics changed the view of the role banks play in economic activity. There are two basic banking functions which make banks the core of the payment system: money creation and the management of the payment system.

As money creators, banks create money by way of deposit liabilities. In contrast to the liabilities of other institutions, bank liabilities (cheques) are generally accepted as a means of payment.[8] Tobin (1969) lists this feature of banks among the eight cornerstones of "a general framework for monetary analysis":

"[As soon as banks are present in the model, money M, issued by the government,]...

[8] The idea that bank deposits can play the role of money is not new; this was a notion of Keynesian macroeconomics in the 1930-s. The novel scientific contribution of the theory is the recognition that banks control the deposit component of money. Therefore, the general money stock is not exogenously determined by the currency issuer, but rather endogenously determined by the banking system.

no longer corresponds to the quantity of money as conventionally defined. Rather it represents "high-powered" money. The money stock would include the public's share of M, plus bank deposits (or, perhaps, only demand deposits...). Thus the money stock would be an endogenous quantity" (p. 27)

As managers of the payment system, banks provide a sound and stable mechanism to effect payments. This task not only involves the payment of cheques, but also of credit and debit cards, automatic teller machines, online banking, and the like. This activity of banks plays a crucial role in determining the relative liquidity of money[9], and thus is of fundamental importance in the study of money demand.

Though portfolio and monetarist approaches to banking contributed to the understanding of banking business and its role in the economy, they both assumed the banking sector as given, without attempting to explain what it is that justifies the existence of banks. If banks are mere institutions that trade financial instruments, as seen by the early banking theorists, this question would be rather insignificant. However, the interest in the active role of banks in the economy gradually grew up in 1960-70s. Based on the ideas of Gurley and Shaw (1955, 1960, 1967), Klein (1971), McKinnon (1973), and others, the more recent contributions to the literature on financial intermediation are based upon three primary issues: (i) the theoretical analysis of the functions of financial intermediaries in the economy, (ii) the analysis of the effects of financial intermediation on economic activity and growth, and (iii) the analysis of effects of government regulation on financial intermediation. I will shortly discuss the three pillars of the theory below.

1.4 Functions of financial intermediaries

From a microeconomic point of view, an individual is generally better off if he/she has a possibility to lend or to borrow. An intertemporal utility maximization problem with only one future state of nature requires that at least one financial asset (storage technology) exists. A market for such a financial asset suffices to ensure the intertemporal optimum for households.

If several future states of nature are possible, the same individual will not be able to achieve his/her intertemporal optimum with the help of the only security. As Arrow (1953)

9 Of course, money has the supreme liquidity. However, the liquidity of deposits may vary, and thus may influence the *relative* liquidity of general money compared to other assets.

showed, a complete financial market is needed to provide the individual with the necessary tools to achieve any desired state contingent wealth allocations, and hence to provide the possibility of achieving the intertemporal optimum through the trade in financial markets.

If financial intermediaries are only debt and securities traders, they do not contribute to the improving the optimality of intertemporal state contingent wealth allocations. Indeed, the existence of financial intermediaries does not increase the number of securities with independent state contingent payoffs, since any portfolio of these securities would only generate a linear combination of payoffs. If the world with financial intermediation cannot outperform the world without them, financial intermediaries could be replaced with financial markets. One of the principal questions of the theory of financial intermediation is why do financial intermediaries exist, and what specific functions of financial intermediaries make them attractive despite the existence of financial markets.

The theory distinguishes between the following functions of financial intermediation: (i) the reduction of transaction costs; (ii) the reduction of liquidity risk; (iii) the information provision; and (iv) the debt renegotiation. The first of these functions concerns the problem of accessibility of financial markets for households/individuals and for firms. The second and the third functions concern the services the banks offer to savers, which cannot be obtained from financial markets. The last function is discussed in the literature starting in the late 1990s and concerns the services a bank offers to its borrowers rather than to depositors.

1.4.1 Reduction of transaction costs

As stressed by Gurley an Shaw (1960), banks transform the credit portfolio demanded by borrowers into a deposit portfolio desired by lenders. This transformation is twofold:

(1) First, banks engage in the transformation of terms: firms prefer to finance their projects with long-term credits, and households prefer short-term deposit for liquidity reasons. Banks are able to accomplish this transformation, though non-financial firms could themselves issue instruments like demand deposits or short-term savings contracts. However, it would be costly for small creditors to write debt contracts with firms (these are complex agreements with restrictive clauses on firm activities). Moreover, small creditors typically like to diversify their risks, which implies greater number of contracts and thus

greater transaction costs. An intermediary is able to exploit economy on scale considerations by writing and enforcing debt contracts with firms.

(2) Second, banks reduce transaction costs through the payment system. For example, a firm or individual who receives a check does not have to verify the solvency of its issuer. Such verification for each transaction would be very costly. Centralizing this process at the level of financial intermediaries avoids wasteful duplication of verification costs.

As Dewatripont and Tirole (1994) note, the vision of banking activities in terms of transaction costs reduction, although relevant, is only incomplete (especially if the issues of control and regulation are concerned), which has stimulated the development of other views regarding bank function.

For example, in his famous model of banks as delegated monitors, Diamond (1984) shows that the existence of banks help to avoid the duplication of audit costs on the part of all creditors. The reduction of monitoring costs, though related to the transaction costs, unveils the information provision function performed by banks. The monitoring issue is elaborated upon below.

The examples above show the reduction of transaction costs on the side of depositors/creditors. On the side of borrowers/firms, the transaction costs reduction can be seen in the example of financial instrument such as loan commitment. A loan commitment may be considered a financial option, which enables a borrower to obtain a loan at predetermined conditions, and may or may not be exercised. Loan commitments may reduce borrowing rates and eliminate the associated moral hazard problems on the borrower's side. These features are available for a commitment fee paid up front, which the borrower sees as sunk costs when making project choice (see Boot, Thakor and Udell, 1987 and 1991; Berkovitch and Greenbaum, 1990). Therefore, the loan commitments provide a possibility for the reduction in transaction costs. At the same time, loan commitments are an example of lending relationships, which provide a basis for debt renegotiation. Debt renegotiation has been recognized in 1990s as another special function of the banks, will be discussed later in the text.

1.4.2 Liquidity provision

Depositors (acting as creditors in their relations with banks) face liquidity risk in sense of possibility needing liquid funds. The trade-off between liquidity and return forces them to hold their wealth (at least partially) in form of bank deposits. Therefore, models of banks as liquidity providers focus rather on bank liabilities than on bank assets (Bryant, 1980; Diamond and Dybvig, 1983). In the famous Diamond-Dybvig model, depositors do not know a priori whether they will face liquidity needs in the future. In order to provide depositors, who withdraw their deposits, with liquid assets, banks need to sell less liquid but more profitable assets thereby reducing their profit opportunities. If many depositors withdraw, others are pushed to imitate this behavior, which produces a phenomenon known as bank runs. Consequently, banks face a dilemma: either to invest in short-term (liquid) assets and not to perform their term-transformation function or to invest (at least partially) in long-term assets and thus face the possibility of bank runs. A solution to this problem is an insured deposit contract, which guarantees the depositors that they get their money back. This prevents the bank runs and suggests an allocation of resources, which is superior to the one without insurance. At the same time, the need of deposit insurance illustrates the necessity of regulatory intervention.

Hellwig (1994) uses Diamond-Dybvig liquidity provision framework to perform a general equilibrium analysis. He focuses not on bank runs but on the optimal return of deposits in the presence of macroeconomic risk. Hellwig shows that when liquidity needs are private information, high interest rates may still fail to prevent depositors from withdrawing, thus inducing possible bank runs depending on macroeconomic performance.

The Diamond-Dybvig setting has become a kind of a standard approach in modelling a banking firm. Examples are the endogenous macroeconomic growth model by Bencivenga and Smith (1991), the financial contagion model by Allen and Gale (2001) and innumerable others. An interesting extension of the Diamond and Dybvig (1983) setting to the case of overlapping generations is the model by Qi (1994), who argues that bank runs can be generated not only by the withdrawals, but also by a lack in deposit inflow.

1.4.3 Information provision

A firm that looks for debt financing typically has a choice between being indebted to the general public or to banks. The public debt is inefficient since it forces each lender to assess firm's solvency, or at least to continuously update rating information provided by specialized agencies. This results either in an increase in monitoring costs, or in subnormal monitoring due to free-riding. Gorton and Penacchi (1990) suggest that debt is a less information intensive asset than equity and thus attracts relatively less informed creditors. Given the natural monopoly aspect of information provision (studied by Leland and Pyle, 1977; Campbell and Kracaw, 1980 and many others), it is logical to presume that the bank debt is more desirable for such creditors than the public debt. A natural monopoly aspect arises here not only because of economies of scale in information provision, but also because of economies of scope since information about a borrower may be obtained by the bank through that borrower's bank account flows.

The information provision function of banks is broadly discussed in the literature on information asymmetry, especially when issues of moral hazard and adverse selection are addressed. Diamond (1984) introduced moral hazard in his model to study how crucial information asymmetry is for the bank. In extension of the transaction costs approach, delegated monitoring not only presumes economies of scale (it is socially optimal when the bank monitors the creditors/firms on behalf of depositors), but also answers the question, why the depositors do not need to monitor the bank itself (to monitor the monitor). The model shows that the moral hazard problem within the bank decreases when the size of the bank increases, and even completely disappears when the bank holds a fully diversified portfolio of assets. Hence, if the bank holds a fully diversified portfolio of assets, the depositors hold risk-free debt contracts and do not need to monitor the bank (at least, they do not need to monitor the bank continuously).

Further examples of banks as information providers are presented in models of Greenwood and Jovanovic (1990) and Boyd and Smith (1992), who analyze the role of the banking sector in economic development and efficiency.

1.4.4 Debt renegotiation

If financial markets were frictionless, solvent firms would always have access to funds to raise their capital for new investment opportunities. Microeconomics of asymmetric information suggest some plausible explanations into why friction in the market, such as moral hazard, adverse selection, and/or agency costs create barriers for the flow of capital to firms with profitable investment opportunities. The role of financial intermediaries as information producers, discussed above, provides a solution of this problem. If capital can flow from creditors (depositors) to the borrowers (firms) through the system of financial intermediation, credit contracts between banks and firms should resemble the debt contracts in the market without financial intermediaries. However, empirical work strongly suggests that bank loans are different from corporate bonds in domestic as well as international capital markets (see e.g. Hallak, 2003).

Theoretically, in a reputation-lending framework, private creditors deny the future access of sovereign defaulters to capital markets (see Eaton and Gersovitz, 1981; Cole, Dow and English, 1995; Grossman and Han, 1999). If a firm defaults on its bonds, it cannot raise additional capital with a new issue of bonds. If such funds can be obtained from banks, firms in financial distress may prefer bank debt to the public debt (bonds).

Diamond (1991) continues to develop his concept of banks as delegated monitors to show why banks can offer loans to firms who can potentially default. The monitoring function of banks is a kind of punishment device for firms. Since banks can monitor firms, and the bondholder cannot, the firms can acquire good reputation through borrowing from banks. The firms, who have acquired good reputation can then switch to the bond market to finance their investment.

Chemmanur and Fulghieri (1994), in contrast, assume that it is the bank who acquires a reputation that distinguishes it from the bondholders. In this case, reputation acts as a commitment device, which ensures borrowers that the bank would make better renegotiation if the firm is in financial distress. The ability to provide better renegotiation conditions is a special feature of financial intermediaries, which is not available in the bonds market.

Bolton and Freixas(2000) stress the relationship aspect of the intermediation. This relationship acts as another kind of commitment: firms know that the banks provide better loan conditions than markets in the times of financial distress. Therefore, firms prefer banks to markets.

Hence, there are at least three reasons, which demonstrate advantages of banks in debt renegotiation (compared to markets): (1) the monitoring advantage of the bank, which acts as a punishment instrument, and therefore allows banks to create better provisions for the reputation creation by firms (2) reputation of the bank as a reliable creditor, which acts as an informal commitment, and (3) the relationship aspect, which also acts as a commitment instrument.

1.4.5 Financial Intermediation in this Dissertation

Although there are different ways (at least four, as discussed above) to justify the existence of financial intermediaries, most models dealing with banking firms focus only on one or two of the reasons for banks to exist. In the context of my analysis, I justify the existence of banks through the transaction costs approach. The reason for this focus is that I compare markets and banks in their ability to link creditors and borrowers (in Chapters 2 and 3) and in their capacity to smoothen a macroeconomic shock (in Chapters 4 and 5). For this purpose, it is sufficient to assume that the only reason justifying banks existence is overcoming the transaction costs barrier, which prevents creditors from entering the financial market. Furthermore, since I do not analyze the effects of financial systems competition (for example, by introducing both banks and markets into one economy), but rather develop a framework in which two different worlds exist (one with financial intermediation, and one with direct market finance), the assumption of transaction costs barrier suffices.

In line with the above mentioned analyses, I compare in how much and whether the bank-based financial system can outperform direct markets in linking creditors and borrowers. I construct a setting where a market-based economy and an intermediation-based one would be equivalent (particularly, dynamically equivalent, as in Chapter 4). Then I introduce distortions like asymmetric beliefs of bankers and depositors with regard to the bailout policy (Chapter 2) or external macroeconomic shock (Chapter 5). This allows to discover some new features of a banking system compared to a market-based system, such as an efficiency issue (banks can fail to link creditors and borrowers if the beliefs of depositors and banks with respect to the solvency of banks are different, see Chapters 2 and 3) and intertemporal shock smoothing issue (see Chapter 5). Both of them stress an important role for banking regulation.

1.5 Financial Intermediation, Macroeconomy and Financial Crises

The functions of financial intermediaries explain why a financial system cannot be reduced to solely financial markets. Each of the functions listed above ensures the existence of a channel between creditors and borrowers in case the market channel is broken. Therefore, if transaction costs are sufficiently high, then market finance becomes unavailable. However, intermediaries can pool creditors on one side, and borrowers on the other, and consequently reduce the transaction costs for each of the creditors and borrowers, thereby providing a channel for the flow of funds. Similarly, asymmetrical information may break the market channel, and through information provision (delegated monitoring) and long-term relationships (delegated renegotiation), intermediaries can provide another link between creditors and borrowers. If creditors are unaware of their future consumption, then they may prefer short term investments, whereas the borrowers still require long-term investment; this term mismatch can also lead to a breakdown of market finance. Intermediaries (provided that they are credible institutions) can transcend the broken market link with their liquidity provision function.

Therefore, the analysis of the functions of financial intermediaries focuses on a single market: a market which enables the flow of funds from creditors to borrowers and back. Financial intermediaries split this market into two parts: the market for contracts between the intermediary and the creditors, and the market for contracts between the intermediary and the borrowers. The analysis of the functions of financial intermediaries still remains within a partial equilibrium approach.[10]

At the same time, the partial equilibrium (microeconomic) analysis does not show the interdependence of different markets and different groups of actors in the economy, and hence only presents a limited picture of the role of financial intermediaries. In particular, the partial equilibrium analysis is limited in assessing possible policies, which can have macroeconomic implications. Dewatripont and Tirole (1994) note:

"The most unexplored topics for research relate to the macroeconomics of banking.

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[10] I call it a partial equilibrium approach in contrast to a general equilibrium one. Perhaps, a better term would be a single market equilibrium.

A coherent general equilibrium framework is required in order to study optimal risk sharing among shareholders, uninsured debtholders (holding junior or senior debt), and the deposit insurance fund. This question is crucial for a proper assessment of more radical reform proposals..." (p.223)

Since financial intermediation is a part of the financial system, it is inevitably related to the macroeconomic development, growth and crises issues.

1.5.1 Financial Intermediation and Economic Growth

The greater availability of investment alternatives through financial intermediation affects the economy through three separate processes: an increase in investment efficiency, a decrease in the cost of transferring capital from original lenders to final borrowers, and a change in the savings rate. Investment efficiency in the economy should increase as a result of the informational advantage held by banks in dealing with borrowers as well as their ability to pool risks as described above. By pooling information pertaining to firms, industries, and the economy as a whole, banks should be able to judge expected returns from investment projects better than individuals and allocate the resources appropriately.

Financial sector development should also induce lower costs of financial intermediation. These costs, which are represented by the spread between bank borrowing and lending interest rates, should decrease as banks gain experience, and an increased supply of financial services leads to more competition among the financial service providers. With lower intermediation costs, a larger share of the savings deposited within banks will find its way to the ultimate borrowers.

The third way in which financial sector development affects the real economy is through the savings rate. However, the sign of this effect is ambiguous. The ability of financial intermediaries to reduce risk through portfolio diversification induces higher expected returns for savers at any level of risk. This may induce savers to either save more as saving becomes more attractive or to save less as a smaller amount of saving is now required to achieve a given savings goal. The overall result depends in particular on the agents' risk preferences. In addition, the availability of a household credit may affect agents' saving behavior negatively since it allows greater dissaving on the part of households. Finally, financial development may result in higher real interest rates on deposits, because of lower intermediation spreads. The effect on the savings rate is once again ambiguous as is the effect on the demand for investment credit.

The overall effect of financial intermediation on economic growth is positive as long as the possible negative effects on the savings rate are not too strong. An assessment of the relative impact of the effects described above requires empirical analysis. However, a particular problem for the empirical work on the effects of intermediation, is the determination of the direction of causality. Empirical concepts of causality are based on evaluating the temporal structure of events: if one type of event consistently precedes another type, it is assumed to be causal. This, however, is not the same as causation in the theoretical sense as, for example, when both types of events may well be caused by a third, unobserved, category. In the case of financial intermediation and economic growth a strong bidirectional relationship seems plausible: financial intermediation facilitates growth, and at the same time, the increased demand for financial services in a growing economy induces growth in the financial sector. In this situation, econometric concepts of causality are not very helpful and empirical research is often limited to the analysis of correlation structures. With regard to the determination of the level of financial development, the papers by Greenwood and Jovanovic (1990) and Saint-Paul (1992) offer frameworks in which economic and financial development are jointly determined, thus providing a macroeconomic linkage for the theory of financial intermediation.

Empirical approaches have been used to assess the impact of financial intermediation on economic activity. A comprehensive study by King and Levine (1992, 1993 a and b) finds a strong correlation between the measures of financial intermediation and economic activity. In addition, in this series of papers, the authors present multi-country evidence that financial development precedes and predicts economic growth. Despite this temporal pattern, however, the question concerning the direction of causality remains open since unobserved variables may drive both developments or financial markets might anticipate future real developments. A similar study has been presented by Atje and Jovanovic (1993). Levine (1997) provides a survey of the literature and concludes that countries with larger banks and more active stock markets grow faster.

A potential explanation why financial intermediation may cause economic growth, is presented and tested by Rajan and Zingales (1998), who conduct an empirical study based on the assumption that deeper financial intermediation results in lower external financing costs for enterprises. In their empirical analysis, the authors rank industries by their dependence on external financing and then check whether those industries relying more heavily on external financial sources become stronger in countries with more developed financial sectors. Analyzing a large sample of developed as well as developing economies, they indeed find a positive link between financial sector development and the success of externally financed industries, which supports the validity of the underlying theoretical consideration.

1.5.2 Financial Intermediation and Macroeconomic Shocks

As discussed above, the liquidity risk arises from the fact that depositors themselves are subject to exogenous shocks and may need to withdraw their money prematurely from long-term projects. By pooling the capital of several investors, banks can invest the capital in long-term projects while still allowing individual investors to withdraw money on demand. This is an example of how banks deal with microeconomic shocks.

A macroeconomic shock hits the economy as a whole. Can the difference in the structure of the financial system[11] influence the recovery speed and/or the damages to the economy? Allen and Gale (1997, 2000) examine the oil shock in the 1970's and show that the American savers suffered more from that shock than the savers in Germany. They argue that the burden of the shock can differ under different financial systems, since financial intermediaries smoothen risks over time. Conversely, American savers could profit more than the German ones when the market boomed.

Gersbach and Wenzelburger (2002 a and b) show that in an intermediated economy temporary negative macroeconomic shocks have long lasting negative consequences on output. Gersbach (2004) demonstrates that if banks can offer deposit contracts contingent on macroeconomic shocks, the risk allocation is efficient (as it should be under complete financial markets), but only if there are no workout incentives, i.e. the public does not expect that the banks are bailed out in case of banking crises. If, however, workouts are possible, the

[11] The structure of financial system determines whether the economy is bank-based or market based.

banks lose incentives to offer shock contingent deposit contracts, and require a high repayment from borrowers in good times and a low repayment in bad times, which increases the macroeconomic risk with time.

Cooper and Ejarique (2000) also find that the presence of intermediation alters the economic development after shocks. They assume the shocks to be intermediation-driven (as a response to a more general macroeconomic shock or to a change in the regulation), which allows one to generalize the results for different settings. Their model does not suit the data for the U.S. economy, and the authors have to adjust the model to introduce production shocks separately to the intermediation shock. As soon as the intermediation process can propagate the real shock, the simulated data are closer to those observed data. However, the authors are unable to find convincing evidence in either case that the intermediation explains aggregate fluctuations in the U.S.. This supports the idea that there is a difference in the development of a market based (U.S) and a bank based economy (e.g. Germany).

1.5.3 Financial Intermediation and Financial Crises

Traditionally, a financial crises is defined in quite broad terms: financial crises either involve sharp declines in asset prices, failures of both large financial and non-financial firms, deflation or disinflation, disruptions in foreign exchange markets, or some combination of all of these. Mishkin (2001) outlines four types of factors that can lead to financial crises: 1) a deterioration of financial sector balance sheets, 2) an increases in interest rates, 3) increases in uncertainty, and 4) the deterioration of non-financial balance sheets due to changes in asset prices.

Banks play a crucial role in the development of financial crises, as they are financial intermediaries that promote the efficient flow of funds from creditors to borrowers. Besides the fact that banks can promote financial crises through their activity in financial markets, which can influence interest rates, uncertainty, and asset prices, crisis in a banking system can also appear, which is then called a banking crisis. Sometimes, financial, exchange, and banking crises are considered separately (see e.g. Sachs, 1998, for details), but mostly they take place together and are united in the term "financial crisis". In 1998, the Governor of the Swedish Central Bank Urban Bäckström even claimed banking crises to be a special monetarist view on financial crises, which could not be recognized as a crisis, if "there is no potential for a banking panic and a resulting sharp decline in the money supply, despite a sharp decline in asset prices". Hence, the monetarist view is too narrow and the crises should be understood in the sense of the broader definition given above. Allen (2001) argues that the crisis does not depend on financial structure and the problem of financial crises is a more general one. Therefore there is no need to distinguish banking crises from financial crises, unless the converse is needed for a specific theoretical model.

There is a plethora of evidence regarding to financial crises in industrial, developing, and emerging economies, as well as in the economies in transition. Kaminsky and Reinhart (1996, 1999) study a wide range of crises in 20 countries, including five industrial and 15 emerging ones. They find that, in many cases, banks were overexposed to the equity and real estate markets, an overexposure that always preceded banking crises. A large scale study on financial fragility and its link to financial liberalization was conducted by Demirguc-Kunt and Detragiache (1998). They find that financial liberalization increases the probability of a banking crisis, but a more sound legislative system and lower level of corruption reduce this effect.

Although there is still no well established unified theory of financial crises, a good review of theories with respect to crises and banks can be found in Allen (2001) and in Rochet (2002).

1.5.4 Macroeconomic Issues in this Dissertation

The analysis in Chapter 5 shows that a bank based economy can fall into a banking crisis after a negative macroeconomic shock, and is hence more vulnerable to an exogenous disturbance than the market one. However, the presence of banking regulation provides intertemporal smoothening of a shock. This issue is very important for the developing and emerging economies, as well as for the economies in transition, which are highly vulnerable with respect to external shocks. In terms of poverty reduction, an intermediated economy prevents sharp decreases in wealth of the population immediately after the shock. I present an empirical example of the role of financial intermediation in the economic development after a shock in Chapter 6, in which I consider the case of the Russian default in August of

1998. This empirical example sheds some light onto the question whether the recovery of the Russian Economy after the shock could have been improved. Particularly, I find that the Russian Government did not respond promptly to the shock, which contributed to the deterioration of the situation and delayed the recovery. The effects of the Russian crisis were somewhat less harmful than could have been expected due to the existence of an alternative storage technology for the household savings, namely U.S. dollars in cash. For a comparison, I discuss also the development of the banking crises in Sweden and Japan.

1.6 Regulation and Intermediation

In the previous sections, I presented a short review of the theories which explain the existence of financial intermediation parallel to or in place of direct financial markets. However, in most cases, financial intermediation can only outperform direct financial markets if properly regulated. As a result, in the Diamond-Dybvig (1983) model of banks as liquidity providers, the absence of government deposit insurance may lead to worse performance by the banks than by the markets, since bank are possible. In general, regulation is needed in areas, in which the presence of financial intermediation can create distortions. These can be allocational distortions with respect to the link between creditors and borrowers or risk-incentive distortions resulting from the moral hazard problem.

With the help of standard microeconomic analysis, Chemillier-Gendreau (1993) studies several particular cases in order to demonstrate that the regulation in banking is, on the one hand, necessary, and on the other hand potentially dangerous. Like in the Diamond-Dybvig's (1983) model, the necessity of regulation stems from the fact that public savings available for investment may be suboptimal under uncertainty. The danger of the regulation lies in its nature as an intervention that can distort optimal allocation (e.g. deposit insurance can create risk incentives for banks, which lead to (socially) suboptimal bank asset portfolios with higher level of risk).

This duality of regulatory interventions makes current banking regulation seek out an optimal trade-off between creating incentives for quality and competitiveness of banking services on the one hand, and the promoting solvency and stability in the industry on the other. Dewatripont and Tirole (1994) provide a discussion on the ways theoretical research can assess the focus of regulation and unveil specific features of banking activities that explain the existence of regulation in the first place. A comprehensive survey of regulatory issues is also presented by Hellwig (1991), Bhattacharya and Thakor (1993) and Freixas and Rochet (1997).

Given the harmful effects of financial crises, one of the principal examination points in banking theory is the prevention of the crises, or more specifically what financial policies can help make crises less likely. Mishkin (2001) suggests 12 basic areas of financial reforms for preventing financial crises: 1) prudential supervision, 2) accounting and disclosure requirements, 3) legal and judicial systems, 4) market based discipline, 5) entry of foreign banks, 6) capital controls, 7) reduction of the role of state-owned financial institutions, 8) restrictions on foreign denominated debt, 9) elimination of too-big-to-fail in the corporate sector, 10) sequencing financial liberalization, 11) monetary policy and price stability, and 12) exchange rate regimes and foreign exchange reserves. All the above listed areas may be summarized in a more general way, namely, preventing informational asymmetry, increasing competition, legislative determinism and institutional stability. Compared to the suggestions of early banking theorists, these areas of financial reforms support the views already expressed in the 19th century. However, as discussed above, at that time, the theory could not provide a convincing explanation for the suggested reforms. Current developments in the modern banking theory suggest a profound theoretical basis for regulatory interventions.

1.6.1 Capital Regulation

The models that address regulatory issues mostly use a simplified view of the bank, assuming deposits to be the only source of outside funds and outside control. One type of model stresses the risk-taking bias implied by the inability of depositors (possibly encouraged by deposit insurance to invest in deposits) to observe the assets portfolio risk chosen by the bank (Merton, 1977, 1978; Bhattacharya, 1982). In such a world, capital requirements reduce risk-taking and, assuming a deposit insurance, the implicit subsidy from deposit insurance.

However, by changing the equilibrium scale of operations of the bank (the banking entrepreneur may react to a decrease in profitability[12] by investing less of his/her own wealth in the bank), capital requirements can also affect the desired composition of assets of a risk-averse bank owner (Koehn and Santomero, 1980; Gennotte and Pyle, 1991; Rochet, 1992). Consequently, it may be the case that higher capital requirements may raise some banks' failure probabilities, although tightening capital requirements generally aims at lowering the probability of failure. The overall effect of capital requirements may therefore be ambiguous. Davies and McManus (1991) show that the same ambiguity concerning risk-taking is present when one increases the net worth level at which banks have to be closed by law.

Milne and Whalley (1998) generalize the basic analysis of moral hazard into a dynamic setting in which there are constraints on the issue of equity capital and a random regulatory audit. In this setting, bank capital is held as a form of self-insurance against poor asset returns. The capital reserves are built up towards a desired level in order to reduce the probability of losing ownership of a future profit stream. This self-insurance interpretation of the bank's capital has a number of implications, both for the relationship between capitalization and risk-taking and for the design of regulatory policy. Milne and Whalley in particular show that the critically undercapitalized bank facing the immediate threat of closure is only concerned with its own economic survival, even if it is fundamentally profitable. This leads to the short-sighted risk-loving behavior suggested by the basic model of moral hazard. On the other hand, a moderately undercapitalized bank is concerned with the future as well as the present, and in order to protect future profits should be risk-averse.

According to Milne and Whalley, bank regulation and supervision should mainly concern itself with identifying bad banks, closing those that are unprofitable, and closely monitoring those with low profits and high asset risk. Minimum capital standards are relatively unimportant as determinants of bank behavior. The only reason why capital standards may remain a primary concern of the regulators is that the capital requirements may reduce the the regulator's exposure to the necessity of resolving failing financial intermediaries. The issue of capital regulation continues to play a very important role in the theory of financial intermediation in contemporary literature. For a comprehensive survey of the literature on bank capital regulation see inter alia Santos (2000).

12 The decrease in profitability is connected with the lower risk premium on the less riskier investment.

1.6.2 Deposit Insurance

There are well known theoretical arguments for state backed deposit insurance (Diamond-Dybvig, 1983, present one of the examples) or more generally for the provision of a bank safety net in order to prevent systemic bank crises (e.g. Demirgüc-Kunt, 2000). However, with a deposit insurance, bankers may wish to exercise riskier investment projects. Moral hazard in banking is seen as one of the causes of the excessive risk-taking, which exacerbated the scale of losses in the savings and loans crisis in the U.S. (late 70-s – early 80-s), banking crisis in Russia (1998) and others. Hence, although deposit insurance intends to increase stability in banking sector, it may also invoke more risk in banking operations.

One of the possible solutions to this dilemma can be seen in a "fair" deposit insurance premium (see e.g. Chan and Mak, 1985 and Ronn and Verma, 1986). A fair price for the insurance takes the actual risk of bank's investments into account. Kim and Santomero (1988) show that if the deposit insurer can control asset choices by banks, it can indeed force banks to undertake less risky projects if insured. Chan, Greenbaum and Thakor (1992) also show that the optimal insurance premium takes on the form of a risk-sensitive contract. However, the implementation of such incentive-compatible, risk-sensitive deposit insurance is impossible if one assumes perfect competition in the banking sector is impossible, and if the insurer uses the capital structure of banks as an indicator for their riskiness. Given competition, banks with riskier investment projects have incentives to copy the capital structure of the les risky banks, and hence the insurance premium is independent on the actual risk of investment projects.

Sleet and Smith (2000) present an interesting (although quite complicated) model, in which both a deposit insurer and a Lender of Last Resort[13] are present. They come to the conclusion that the pricing of deposit insurance may be irrelevant from the welfare perspective, since any change in the insurance premium results in a corresponding change in the deposit interest rate. Nonetheless, this result seems to be crucially dependent on the assumption of an absolutely inelastic supply of deposits.

Most models of deposit insurance assume that the volatility of a bank's assets is exogenously provided. Although this framework allows one to study the impact of volatility on

[13] See also the subsection **??** on the bailout policy below.

bankruptcy costs and deposit insurance subsidies, it is static and does not incorporate the fact that equity holders can respond to market events by adjusting previous investment , thereby exerting a certain degree of leverage. Ritchken, DeGennaro and Li (1993) present a dynamic model of a bank that allows for such behavior. The flexibility of being able to respond dynamically to market information is of value for holders of equity. The impact and value of this flexibility option are explored in a regime in which flat-rate deposit insurance is provided.

Usage of a special certification system as an alternative (or complementing element) to insurance contracts in order to prevent crisis is also underlined in Perrot (1998) and Avdasheva and Yakovlev (1998) who use Russian data. Despite the clear insurance benefits, this and similar approaches may lead to the excessive risk-taking by financial intermediaries. This point of view is supported in many papers devoted to the problems of asymmetric information in financial markets. For example, Smith and White (1988) show that excessive risk-taking and insufficient monitoring hurt Canadian economy where a system of deposit insurance was established in 1967. The regulatory guarantee for the value of deposits removes incentives for depositors to monitor bank portfolio allocations or to seek a return that compensates for the risk of liquidation. Such a guarantee also creates incentives to transfer as much value as possible out of the failing institutions into the hands of shareholders («looting» or «milking the property»). Such transfers both legal and fraudulent also contribute to the scale of banking crises (see Akerlof and Romer, 1993).

Bhattacharya, Boot and Thakor (1998) provide a review of banking regulation with a discussion of possible alternatives to the deposit insurance. A detailed survey of the literature on deposit insurance issues can be found in Frolov (2004).

1.6.3 Bailout Policy

The problems related to the bailout policy can be summarized in one question : "to bailout or not to bailout?" If financial intermediaries know they would be bailed out in case of a financial distress, they would have less incentives to restrain their risk activities, and hence moral hazard increases. If financial intermediaries are not bailed out, this may lead to significant social losses. A bailout can be conditional (contingent), as suggested by Bagehot

(1873) or probabilistic (stochastic) as in Freixas (2000). However, there may not be any uncertainty about the rules of the bailout (Hakenes, Schnabel, 2004).

The bailout policy is hence in the center of the research in banking regulation. If the theory of banking capital is a response of the banking theory to the suggestions of the Basle Committee on banking regulation, then the theory of bailouts is a response of the part of the theoretical community to the ambiguity in the practice of bailouts in banking systems all over the world. Bennett (2001) presents a survey of actual practices of failure resolutions in the banking sector, which proves that banks are bailed out even if the authorities initially claim they will do the opposite. The practice of forbearance[14] during failure resolutions is a matter of fact.

Such an ambiguous bailout practice leads modern banking theorists to Bagehot's question of whether it is optimal to save a solvent but illiquid bank. One of the objections to this concept is that a solvent bank can always find liquidity assistance from the market. Rochet and Vives (2002) present a model of banks' liquidity crises, which exhibits an equilibrium in which a solvent bank cannot obtain liquidity assistance from the market. Freixas (2000) shows that a bailout with a positive probability is the optimal policy for a Lender of Last Resort. Nonetheless, the debates in this field of theory are far from finished.

1.6.4 Regulation of the Structure of Banking System

A regulation imposed on banks does not end with the capital adequacy requirements and the state-backed insurance system. Setting up the structure of the banking sector also may induce changes in the development of the financial system. Quite a bit of attention has been paid to the discussion, sophisticated models, and empirical tests regarding the structure of the banking sector.

Chong, Liu and Altunbas (1996) examine the effects of the Financial System Reform Act (FSRA) on the risks and returns of Japanese commercial banks, long-term credit banks, trust banks, and securities firms. By setting the stage for universal banking in Japan in 1992, the FSRA had tremendous implications for the competitiveness, efficiency, and stability of the

[14] Forbearance in this context means that the regulatory bodies tend to delay with bankruptcy procedures and let the failing institutions operate further. See Chapter 2 for details.

Japanese financial services industry. Using an event study methodology, Chong, Liu and Altunbas show that universal banking in Japan in particular, increased the Japanese financial institutions' exposure to market risk, but lowered their exposure to interest rate risk. Among the Japanese financial institutions examined, only the trust banks and the securities firms seem to benefit from the FSRA in terms of increased returns.

In my paper (Vinogradov, 1997), I suggest that the vulnerability of the Russian banking system in the 1980-90s was mainly due to the universality of the banking: the banks were free to select the investment opportunities. In such a situation, when one market proves to be significantly more profitable than the other, banks tend to concentrate their resources in the more profitable (but mostly also more risky) market. One of the policy implications of the analysis was that a segmentation of the banking sector would create conditions for greater financial stability in the country.

A number of authors have analyzed the link between competition and prudential concerns. They have stressed the fact that the expectation of future gains makes it more costly for a bank to fail and introduces a mitigating factor against excessive risk taking. Bhattacharya (1982) has argued that deposit rate ceilings could act as such a deterrent against risk taking. Besanko and Thakor (1992) have shown that lower entry barriers can be Pareto worsening if they induce a large increase in risk taking. Chan, Greenbaum and Thakor (1992) argued that the existence of sufficient gains may be a prerequisite for a useful role for risk-sensitive deposit insurance premiums.

Debates in the U.S. on the need to maintain legal barriers (firewalls) between commercial and non-traditional banking motivated Chen and Mazumdar (1997) to develop a theoretical model that examines the joint influence of various factors, including competition and regulatory subsidies, that affect the bank's incentive to partake in non-traditional activities. They find that if the entry and exit costs for the non-traditional segment or the risk of non-traditional business are sufficiently high, then the firewalls and/or subsidies play no distinct role and such policies could be abandoned. But if the entry/exit costs are low enough, the the regulation of the structure may be expedient.

1.6.5 Monetary Policy

Another type of banking regulation is the impact of monetary policy on banks' behavior. In this case, the regulation may be either direct (through reserve requirements and discount rate) or indirect (through tightening money supply). With regard to possible monetary controls, I would like to stress the role of deposit rate ceilings, which nowadays are often claimed to be useless in monetary policy. An example of a paper advocating deposit rate ceilings is Rolnick (1987), who shows that deposit rate ceilings can be an effective instrument in banking regulation. Rolnick focuses on the risk-controlling effect of deposit rate ceilings. Another role for the ceilings is assumed in the models of Gersbach and Wenzelburger (2002) as well as my own (Vinogradov, 2003; Mavrotas and Vinogradov, 2005; and this dissertation). In these models, deposit rate ceilings provide a profit opportunity for banks in financial distress, which allows them to cover the deficit in reserves, and as a result leads an economy to a recovery after macroeconomic shocks.

Monetary policy effects on the banking sector are widely discussed in the literature on monetary theory and policy. Benston and Smith (1976) note that banks are traditionally considered to be intermediaries for the government to control the money supply in an economy. This role as a government's financial agents that transmit monetary policy to the economy, stresses the importance of reserve requirements as the scope of analysis.

However, it is commonly accepted that banks in turn react to the implemented monetary policy, and thus effects of the policy should be studied as well. Bernanke and Blinder (1992) provide an analysis of how banks may react to tight monetary policy and develop a model that demonstrates non-simultaneous changes in the value of credits and securities in bank's portfolio. Roubini and Sala-i-Martin (1992) discuss the effects of public policy on financial development and show that a financial repression may lie in the short-term interest of policy makers as it allows them to collect revenues, for example through the application of minimum reserve requirements and through inflation. Empirically, they find a negative correlation between financial repression and economic growth.

1.6.6 Regulatory Issues in this Dissertation

In this work, I consider two aspects of regulation: the role of the bailout policy (insurance pillar of the regulation) and the regulation of the competition (possibly combined with capital adequacy rules, which extends the discussion into the third pillar of the regulation, the prudential supervision). In Chapters 2 and 3, I show that a bailout policy has a positive announcement effect in the world in which depositors' and bankers' beliefs regarding the liquidation of an insolvent (but not necessarily bankrupt) bank are asymmetrical. As the above mentioned review shows, the result of most of the literature on bailout policy effects under informational asymmetry is the moral hazard problem: banks tend to take on more risk, and therefore bailouts may be harmful. In contrast, I show that the absence of such a policy can lead to an inefficient allocation of funds in an economy with intermediaries as compared to a market-based economy. I discuss in Chapter 3 a bailout policy of the regulator, which combines forbearance and uncertainty, and show that such policy may be optimal for the economy. In Chapters 4 and 5, I consider effectively risk-free economies in which markets and banks provide a dynamically efficient allocation of funds. However, an introduction of an exogenous macroeconomic shock stresses the role of the bailout policy, which lets the banks successfully borrow funds from the future generations. At the same time, such a bailout policy alone cannot provide the necessary conditions for recovery of the intermediated economy after a shock. Complementary regulation which, for example, establishes a deposit rate ceiling based on a capital adequacy ratio is needed.

1.7 Summary

The stability of banking systems was the principal topic of interest in the theory of banking over the last centuries. The early banking theory provided suggestions in regards to banking reforms based on the consideration of banking practice. The suggested reforms faced difficulties in implementation due to the lack of plausibility in the banking theory. The revival of the theory was possible in the 1960s after a change in way in which intermediaries were viewed, as it was recognized that banks play an active role in the economy, in contrast to the vision of banks as trading houses of the 19th century.

Further developments in the banking theory included the study of specific functions of financial intermediaries, which distinguish them from other actors in financial markets. These functions justify the existence of financial intermediation and at the same time provide a tool for the study of regulatory interventions. Modern banking theory suggests a theoretical background for the elaboration of regulatory measures aimed at the banking stability.

In this dissertation, I study two principal issues: (1) comparative advantages and disadvantages of bank based systems relative to the market based systems, and (2) the role of bailout policy. In Chapter 2, I present an example in which a bank based system can fail to link creditors and borrowers. In Chapter 5, I show that, following a negative macroeconomic shock in a dynamic context, an insufficient regulation can lead to a banking crisis, whereas a market economy survives after the shock.

With regard to the regulation, Chapter 3 demonstrates that a bailout policy has an announcement effect, which eliminates asymmetry in the views of depositors and bankers with regard to the failure resolutions, and thus may provide a basis for an efficient allocation of funds in the bank based economy. In Chapter 4, I construct a dynamic general equilibrium model, which proves the dynamic equivalence of the market economy and the bank based one in a world with certainty. In Chapter 5, I introduce some uncertainty in form of an effectively unanticipated shock and show that this destroys the equivalence, namely that the bank based economy can fall into a banking crisis. An introduction of a proper regulation may provide a bank based economy with an ability to recover after the shock. Moreover, the dynamics of recovery demonstrate the ability of a bank based system to smoothen out the negative consequences of the shock over several periods, and thus provides a comparative advantage for the bank based system compared to the market based system.

Chapter 2
Ambiguity in Bailout Policy and Efficiency of Intermediation

If the Regulator does not commit to following a precise bailout rule, an ambiguity arises with regards to bailouts. This chapter presents a simple model with which one can examine whether or not the policy of ambiguous bailouts can be harmful for the economy. The model assumes a world in which agents have no asymmetry in the information *available* to them, but may have asymmetry in their treatment of *missing* information. In the case of an ambiguous bailout policy, they can still differ in their beliefs regarding whether or not an insolvent bank will be closed (liquidated) even if both depositors and bankers are symmetrically informed about the composition of banks' portfolios, and hence can judge the solvency of the bank in the future. I show that such asymmetry in beliefs can generate inefficiency in an intermediated economy compared to the market economy.

2.1 Bailouts and Rescue Beliefs

Arrow (1953) showed that in a world with complete financial markets, symmetric information and no frictions, a competitive equilibrium outcome is optimal. If the information about the issuers of securities in financial markets is perfect, and if all actors in the economy have a frictionless access to financial markets, then an efficient allocation of resources in the economy is guaranteed. This fact suggests that a frictionless market equilibrium allocation can be used in theory as a reference point in assessing the efficiency of the allocation achieved by other means.

The theory of financial intermediation suggests that in case of distortions, which prevent the equilibrium market allocation from being optimal, financial intermediaries can reestablish optimality. Such distortions include (1) transaction costs, which create obstacles in accessing the markets and (2) informational asymmetries. Of course, intermediaries cannot solve this problem if the markets are incomplete, unless the intermediaries issue missing securities. Nonetheless, a frictionless competitive market equilibrium is still a good reference point with which the intermediated economy may be compared. Arrow (1963) writes:

> *"The failure of one or more of the competitive preconditions has as its most immediate and obvious consequence a reduction in welfare below that obtainable from existing resources and technology, in the sense of a failure to reach an optimal state in the sense of Pareto... When the market fails to achieve an optimal state, society will, to some extent at least, recognise the gap, and nonmarket social institution will arise attempting to bridge it." (p.947)*

Assume that financial markets are complete. In Chapter 1, I reviewed the main results of the theory of financial intermediation, which explain the existence of intermediaries through their role in "bridging the gap" which arises from the frictions in financial markets. In some situations (like Diamond-Dybvig, 1983), bridging the gap is only possible if a regulatory system exists, which implements special regulatory measures. This explains the existence of the regulation.

In this chapter, I discuss a particular case of complete markets (two securities and two states of nature) and symmetric information (all agents have information about the risk properties of the underlying market securities, and depositors have complete information about the investment portfolio of the banks). I consider the market economy as a reference point for examining what constitutes an optimal allocation of resources. Then I consider a world, in which creditors have no access to the financial market (due to high transaction costs), but instead can deposit their savings in the bank. In such a world, financial intermediation can fail to provide the optimal allocation if the views of depositors and banks differ regarding whether or not an insolvent bank will be closed. Whether or not depositors believe that the bank will always keep its promises, in other words whether the principle of the limited liability is valid, is the decisive issue.

2.1.1 Failure Resolutions

Dewatripont and Tirole (1994) distinguish between four ways of handling bank failures:

(1) liquidation (payoff resolution), when the bank is closed and put under receivership, and uninsured claimants are paid off after the assets of the bank are liquidated;

(2) merger (purchase and assumption), when a healthy bank purchases all or some of the assets of the failed bank and assumes all or some of the liabilities;

(3) government loans or transfers (open bank assistance), when the supervisory agency provides financial assistance to a failed bank in the form of loans, asset purchases or cash to restore a positive level capital; and

(4) government ownership (bridge bank), with a supervisory agency temporarily taking over the operations of a failing bank and maintaining banking services for the customers.

Freixas (2000) extends this list to a total of ten possible policy interventions, which include some modified forms of those listed above. As Freixas notes, several forms of resolutions "may be either part of a rescue package or lead to liquidation," which are the simplified forms he considers in his paper. I follow this approach of distinguishing between rescue and liquidation, but I stress that depositors and bankers can differ in their perception of whether a particular policy intervention is a rescue or a liquidation. From the point of view of the customers, the bank is closed only in one of the four cases, namely in the liquidation case. In all other cases, customers can continue working with the bank, regardless if it is rescued, assumed or nationalised. From the point of view of the banker however, the bank continues its operations only if it is bailed out through loans or transfers, since it is otherwise either liquidated or assumed by another institution, in which case, the failed bank itself is no longer liable to its customers. This point deserves special attention and I discuss this asymmetry later on. [15]

Most research in the field of bank failure resolutions concentrates on resolving illiquid but solvent banks. Following standard definitions, insolvency occurs when the value of the assets

[15] Bennett (2001) provides with a detailed discussion on international evidence on the types of resolution, based upon a survey on deposit insurance practice in 34 countries, including advanced, developing and transitional economies. See also Santomero and Hoffman (1998) for the discussion of problem banks resolution methods and Bhattacharya, Boot and Thakor (1998) for a discussion of theoretical views on bank closure policy.

held by a bank is less that the value of the liabilities held; illiquidity occurs when a bank is not able to meet its current obligations as they come due, so that illiquidity can arise even if a bank is solvent (e.g. due to banking panics). It is possible that insolvency arises when a bank is still liquid, and this case seems to be studied much less in the literature. Gersbach and Wenzelburger (2002a and b) show that in a dynamic setting, insolvent banks (whose liabilities are greater than their assets) can still be liquid due to newly acquired deposits which provide them with sufficient liquidity to pay off debt to the previous generation of depositors.

For theoretical models, these considerations imply in a dynamic setting that if banks are insolvent in one period and their capital (difference between assets and liabilities) falls below zero in that period (or is insufficient if the capital adequacy rule is considered), they can still continue operating and simply start the next period with insufficient or negative capital. In a static setting, under the assumption of the *limited liability*, it is usually assumed that banks are closed in the case of insufficient capital, which implies that the bank's profit is always nonnegative: if it is negative, the bank is closed, and the net profit of the banker is zero, whereas its losses are borne by bank's creditors[16], who only receive the liquidation value of the bank. This approach is not always consistent with the actual practice, since regulators often delay failure resolutions in a hope of a turn around (see e.g. Bennett, 2001). In two-period models (in contrast to dynamic models), it is difficult to account for the possibility of any resolution forbearance, since in a standard description of a two-period model, "the world ends in the second period". In the following text, I develop a two-period model, in which banks may believe to be able to pay on their obligations even in case of insolvency. The intuition behind this rather hypothetical assumption is the possibility that banks may be rescued through an open bank assistance. I will come back to the issue of the regulatory forbearance in Chapter 3.

2.1.2 Constructive Ambiguity

As discussed in Chapter 1, the question of whether a failing banking institution should be

[16] In the model, bank's creditors are its depositors. In the general discussion here, it is sometimes convenient to refer to them as creditors. In particular, this allows to stress that these are the same individuals, who act as creditors of banks in the bank-based economy, and as creditors of firms in the market-based economy below.

saved or closed was discussed by Bagehot (1873). Bagehot insisted that there should exist a precise rule which determines under which conditions illiquid banks should be closed or not. Since the actual practice still includes some ambiguity with respect to the closure of failing banks, the theory attempts to provide a rationale for that.

Nonetheless, regulators do not pursue a strategy of commitment to either the liquidation or the bailout of failing banks (examples of empirical studies are Goodhart and Schoenmaker, 1995, Santomero and Hoffman, 1998, Bennett, 2001). The term "constructive ambiguity" was made popular by Gerald Corrigan (1990) while he was the President of the New York Federal Reserve Bank. Enoch, Stella and Khamis (1997) summarize the key arguments for and against the ambiguity in the policy of the Regulator. They state:

> *"...In order to reduce the risk of a banking crisis and to protect small depositors in banks, most countries' authorities operate with some form of financial safety net for banks in distress and their depositors... The existence of a safety net also leads to problems. In particular, there is the possibility of moral hazard - i.e. managers, owners, creditors, and depositors of banks may be less prudent in their behavior than if they expect to bear the full concequences of a bank failure... Many central banks, in an effort to reduce moral hazard... maintain some constructive ambiguity with regards to how, when and whether they will employ their safety nets." (p.4)*

Therefore, in bailout oriented theoretical models, there is a need for precision with respect to the three questions "how?", "when?" and "whether?", which determine the ambiguity. The answer to the first question determines the methods of the failure resolutions. In this chapter, I compare liquidation versus bailouts through subsidy as Freixas (2000) also does. The answer to the second question determines the timing of the resolution. In the two-period setting used in this chapter, forbearance is not a possibility, and the failure resolution takes place immediately after the insolvency is reached. Finally, the last question determines whether the Regulator commits to a certain rule.

One source of ambiguity is seen in the fact that the Regulator needs to collect and to process all the relevant information in order to be able to face the optimal decision with regards to the failure resolution (see Enoch, Stella and Khamis, 1997, for a brief discussion of this issue). In this case, the decision regarding bailout is made *after* the insolvency takes place, and such a decision is assumed to be *ex-post* optimal. Theoretically, it is possible that the public creates *ex-ante* beliefs with regards to the future bailout policy. Although I do not explicitly model the Regulator's decision making or the public's belief, the model predicts that if such beliefs on the side of depositors and on the side of bankers are not symmetric, then the allocation of resources in the intermediated economy may differ from the one achieved in the market economy. I consider the allocation achieved in the market economy as a reference point for judging the efficiency of the equilibrium allocation. Achieving the same allocation of resources as in the market economy may therefore be an additional rationale for regulators' bailout policies.

A commitment to a certain rule does not necessarily assume a commitment to either liquidation or bailout. Freixas (2000) discusses a possibility of a "constructive ambiguity" with regards to bailouts and introduces a probability z of a bailout to apply the costs-benefits approach to the study of optimal bailout policy. He shows that saving banks with some positive probability (which is smaller than one) can be optimal for the Regulator. In fact, such bailout policy is not ambiguous, although it is uncertain in sense of Arrow (1963), since there is a probability distribution over the possible outcomes, and this probability is known to the actors in the economy. In contrast, an ambiguous bailout policy neither defines a contingent rule of saving banks (contingent bailouts in sense of Bagehot, 1873), nor does it define a probabilistic rule of saving banks (which could be interpreted, as though a certain fraction of banks is saved in case of a failure).

In this chapter, I compare ambiguous and uncertain bailout policies. If the general public has no information about the Regulator's bailout policy, an asymmetry in beliefs with regards to bailouts can appear. In order to model the uncertainty of bailouts, I introduce a probabilistic bailout rule à la Freixas (2000) which eliminates the asymmetry in beliefs between depositors and bankers. This underlines the difference between ambiguous bailouts and uncertain (probabilistic) bailouts.[17] Informing the public about the probability of bailouts z provides the public with additional information, while at the same time preserving the uncertainty of bailouts. This additional piece of information suffices to correct the asymmetry in beliefs and to improve the efficiency of financial intermediation in the allocation of resources.

[17] One might call it also a stochastic bailout rule, see also Kocherlakota and Shim (2005).

In addition to Bennett (2001), there are other documentations of the ambiguity (or non-commitment) in the bailout policy of regulatory authorities. Goodhart and Schoenmaker (1995) present an empirical study of the bailout policy around the globe, and construct a sample of 104 failing banks, of which 73 were rescued and 31 were liquidated. Santomero and Hoffman (1998) present evidence that an access to the discount window in the US was often granted to institutions that ended up failing. They write:

> *"Often economists are quick to argue that failure should have a rapid and brutal response. Failed private institutions should pay the private penalty for default. However, while this result may be viable in theory, it is never employed in practice. In reality, the options open to the Regulator will depend not only on the state of the institutions involved, but also on the state of the industry and the broader financial market itself" (p. 7)*

In this chapter, I consider three cases: 1) the case, in which the Regulator commits to a closure of insolvent banks; 2) a non-commitment case, in which there is ambiguity with regards to a bailout; and 3) a case of uncertainty with regards to bailouts which can be performed with some probability z known to the public. The public's expectations of failure resolutions in the future is a crucial factor.

2.1.3 Rescue Beliefs

As previously mentioned, there is a difference in how the depositors and the banks view the resolution methods. Whether depositors receive their funds, depends on the resolution method chosen. In the case of a subsidy (or a continuation loan), deposit repayments are certain. If the failing institution is assumed through a merger, acquisition or nationalisation, its liabilities are not necessarily assumed in full, so that depositors can generally expect partial repayments. Finally, if the failed financial institution is liquidated, its uninsured creditors receive only the value of bank's assets. This asymmetry in views of bankers and depositors with regards to possible outcomes, plays an crucial role in the model. Which insolvency resolution method depositors believe will be applied in case of insolvency, determines their expected payoff function, and hence, the decision of how much to deposit.

In the model in this chapter, there are only two possibilities: either a bank is closed, or it is saved through an open-bank assistance, which is assumed to be financed through taxes from the population. If the Regulator commits to closing a failing bank, then both depositors and bankers expect liquidation. In a non-commitment case, it is possible that both depositors and bankers expect liquidation, in which case it does not differ from the commitment case. It is also possible that both depositors and bankers expect a failing bank to be rescued, which provides a case of symmetric beliefs. Symmetric cases have been studied by Sinn (2003).[18]

The most interesting case arises if the banker believes the bank will not be closed in the case of insolvency, but the depositors expect the bank to be closed if insolvency occurs. In this situation, the beliefs of depositors and bankers are asymmetrical. The banker expects to obtain a loan or some other form of assistance to rescue the bank. This is mainly relevant only in a dynamic setting, in which it is possible that a bank operates for many periods, and I return to this case in the next chapter. However, the hypothetical question what *would* happen if the banks *were* to act *as though* they could repay all obligations to their depositors and end up with a negative net worth, can be studied in a static framework as well. This would help to understand, why a policy of ambiguous bailouts can be harmful.

The literature on banking crises and panics stresses that asymmetry in the views of depositors and bankers makes crises more severe and limits the abilities of regulatory agencies to rescue banks through liquidity provision by monetary policy means (good references for this case are Calomiris and Mason, 1997, or Corbet and Mitchell, 2000). However, the asymmetry is treated in a way that depositors (and the Regulator) overestimate the banks' portfolio risk compared to the estimation by the banks themselves. In my model, there is no asymmetry in information in this sense: all agents have correct information regarding the riskiness of the banks' assets. On the contrary, asymmetry arises only in the case of ambiguous bailouts, and is presented in the difference in beliefs of depositors and banks with regards to outcomes in case of banks' insolvency.

2.2 Market Economy

Consider an economy with a continuum of agents called households [indexed by] $i \in [0;1]$, and two types of financial assets, one risky an one risk-free. The model describes two

18 Sinn (2003) studies the issue of limited and unlimited liability. Nonetheless, the results are directly applicable to the case of failure resolutions and respective beliefs. In the next chapter, I discuss the role of the limited or unlimited liability in my model in greater depth.

periods: in the first period, decisions and investments are made, and in the second period, one of the two possible states of nature are realized (H for high and L for low). The economy ends at the end of the second period.

It may be convenient to think of the risky asset as of an investment project like a production technology, which brings two different outcomes in two different states of nature. Since I focus here on a partial equilibrium analysis, and study only the distribution of resources between the risky and the risk-free alternatives, I prefer to interpret the risky investment project as the risky financial asset. This simplifies the exposition.

2.2.1 Markets

The markets of both risky and risk-free assets are characterized by an absolutely elastic supply of assets. This allows one to focus on the allocative properties of the economy, leaving price effects aside. A possible interpretation of this assumption is discussed in the next chapter.

The risky asset yields a rate of return of r^H in the second period, if the state of nature "H" is realized, with probability p, and of r^L; if the state of nature "L" is realized, with probability $(1 - \ p)$.

I will assume that

$$r^H > r^F > r^L \tag{A-2-1}$$

and

$$pr^H + (1-p)r^L > r^F \tag{A-2-2}$$

The first assumption excludes trivial decisions of the decision-makers. The case of equality is trivial and does not allow for any uncertainty. The case $r^H > r^L \geq r^F$ (and similarly $r^F \geq r^H > r^L$) is not particularly of interest since it eliminates uncertainty in agents' decisions: the risky asset is preferred to the safe one since it yields a higher or equal rate of return in any state of nature (or the safe asset is always preferred to the risky one, respectively).

The second assumption guarantees that the expected return on the risky asset is higher than the return on the risk-free asset.

Finally, I assume that short sales are not allowed. This guarantees that the amount invested in financial assets is not negative.

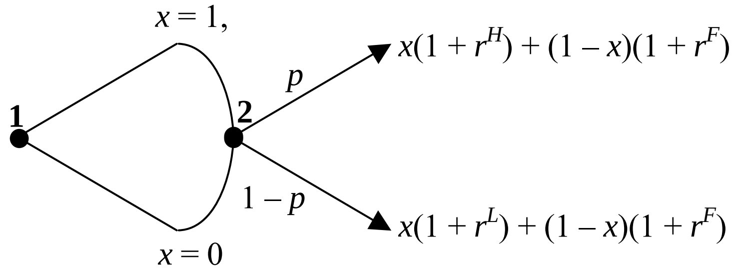

Figure 2.1. Decision-tree of a household

2.2.2 Households

All households in the model are equal in their preferences and abilities so that there is no heterogeneity. The households have to decide in what composition of a portfolio of risky and risk-free assets to invest their endowment of a unit size. One can understand this endowment as a normalized solution of a consumption-saving optimization problem so that the households now only decide the optimal investment level of their savings of the unit size. The share x of their investment portfolio is for the risky asset, and the share $(1-x)$ is for the safe asset. Since short sales are not allowed, $0 \leq x \leq 1$.

Figure **??** illustrates the decision-making of a household in form of a decision tree. The decision node 1 corresponds to the choice of the household. The houshold decides upon investing one unit of savings into a portfolio with a share x of risky asset and a share $(1-x)$ of a risk-free asset. In node 2 the nature determines the state of the nature "H" or "L". With the probability p the "H"-state of nature occurs, and the risky asset yields the rate of return r^H. With the probability of $(1-p)$ the "L"-state of nature occurs and the risky asset yields the rate of return r^L. Since the action space for the household is a continuum $x \in [0;1]$, the lower and upper limits for x are placed at the bottom and top of the arc joining two edges protruding from the decision node 1. The infinite number of resulting decision nodes 2 are represented by a single node placed in the centre of the arc.

Since the probability p of the "H" state of nature and the probability $(1-p)$ of the "L" state of nature is known, one can determine the expected profit of the household. A risk-neutral household would maximize its expected profit:

$$\begin{aligned} G^e &= x\left[p\left(1+r^H\right)+(1-p)\left(1+r^L\right)\right]+(1-x)\left(1+r^F\right) \rightarrow \max_x \\ \text{s.t. } 0 &\leq x \leq 1 \end{aligned} \tag{2.1}$$

Remember that the endowment of depositors is normalized to unity, and that they do not solve a consumption-saving optimisation problem. Therefore, the sole control variable in the optimization problem (**??**) is the share of the risky asset x.

2.2.3 Equilibrium

Due to the linearity of the expected profit function in x and due to Assumption **??**, the first derivative of the expected profit function of the households is positive:

$$\frac{\partial G^e}{\partial x} = pr^H + (1-p)\,r^L - r^F > 0$$

Therefore, the optimal decision of any household is $x^* = 1$. This implies that in the market economy the aggregate demand X for the risky asset is equal to unity:

$$X = \int_0^1 x^* di = 1 \tag{2.2}$$

Under absolutely elastic supply of financial assets, this is also the equilibrium outcome.

Definition 2.1 Market equilibrium is the allocation of funds $X^* = \int_0^1 x^* di$ with $x^* \in \arg\max G^e$.

The definition of the market equilibrium uses the assumption of the absolute price-elasticity of the supply of financial assets. Hence there is no need to determine the equilibrium price and the demand for assets determines the equilibrium allocation. The definition of the market equilibrium stresses that the equilibrium allocation is given by the aggregate demand for the risky asset. In the next chapter, I discuss a possible explanation of this assumption.

Corollary 2.1 *In the market economy, the households invest their complete endowment in the risky asset*

I use this result as a reference point to compare the equilibrium allocation in the intermediated economy with that of the market economy.

2.3 Intermediated Economy: Commitment to Liquidation

Consider the same economy as above, but introduce the transaction costs for the market for the risky asset so that the households have no access to it. However, households still have an access to the market of the risk-free asset. The theory of financial intermediation predicts that given these conditions financial intermediaries would be able to exercise economies of scale and would provide the households with the possibility of buying a financial contract as an alternative to the risk-free asset. I consider financial intermediaries in the form of banks which offer households a standard deposit contract. The standard deposit contract (as opposed to state-contingent contracts, for example) is a debt contract between a bank and a depositor, with a duration of one period and without an option of premature termination. Ideally, financial intermediation provides a link between creditors (households) and borrowers (firms, which are not directly modelled here, but rather represented through the risky asset), which allows one to achieve the same allocation of resources as in case of the market economy.

Again, there are two periods in the model. The sequence of events in the economy is presented in Figure **??**. In the first period, three actions take place: first, banks are created, then deposits are collected and, finally, banks create their investment portfolio. After the state of nature is realized, the second period begins and four actions take place: first, banks reap portfolio gains, then deposits are repaid, and then the banks' profits are distributed to the shareholders, after which the banks are closed. The economy ends at the end of the second period.

The objective of the analysis is to study the allocation of one unit of the households' endowment in the portfolio of risky and risk-free assets. It is important that the decision of the banks is separated from the that of the households. Therefore, even if the banks belong to households, the latter cannot influence the decision of the banks. Hence, the decision of households with regards to the composition of their portfolio of risk-free assets and deposits does not depend on whether households receive the profit of the banks as an additional payoff at the end of the second period. It is convenient to assume that banks belong to all households

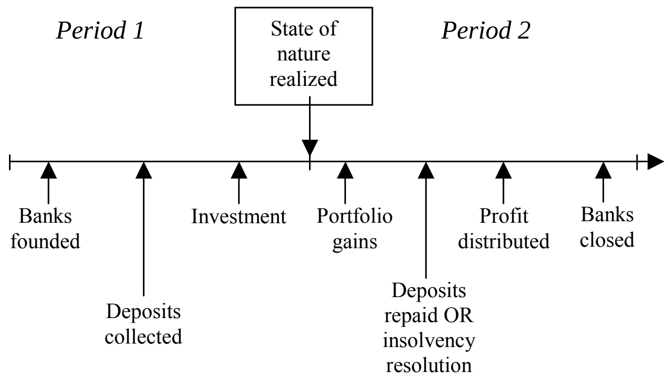

Figure 2.2. The sequence of events in the intermediated economy

in equal shares.

Along with financial intermediation (in the form of banks), there is also a regulatory authority present in the economy. The regulatory authority (I will refer to it as the Regulator) is responsible for insolvency resolutions. A bank is called **insolvent** if the total value of its assets is below the total value of its liabilities. If a bank is insolvent, there is a need for a regulatory intervention, which generally can take on two forms: either a liquidation of an insolvent bank or a bailout through an open bank assistance.

Here I consider the case in which the Regulator is committed to the policy of closing insolvent banks. This means that the Regulator guarantees that in the case of insolvency, the proceeds of the financial portfolio of the insolvent bank are paid off to the bank's depositors proportional to the size of deposit made by each individual household.

It is important to distinguish between two meanings of the term "liquidation". The first meaning is the insolvency liquidation as described above. The second meaning refers to the liquidation (closure) at the end of the second period in this two-period model. In this context, the liquidation of a solvent bank means that the deposits are paid in full and the shareholders of the bank receive the bank's profit.

Hereinafter I will use the term "liquidation" to describe the insolvency resolution procedure unless otherwise specified.

2.3.1 Banks

In the general description, no assumptions regarding the number of banks in the economy are made. I will consider the case of a monopolistic banking sector and the case of a competitive banking sector later on. Until then, I will use the singular for convenience.

The bank collects deposits in amount D at the rate of return r^D and invest them in a portfolio with a share x of risky and $(1-x)$ of safe assets. Bank managers determine the bank's demand for deposits and the portfolio composition to maximize the expected profit of the bank, which maximizes the wealth of the bank's shareholders. I assume that the banks belong to the households in equal shares. For simplicity, I refer to bank managers as bankers in the following text.

The decision tree of the bankers is given in Figure **??**. In node 1, bankers determine the amount D of deposits invested in a portfolio with the share x of the risky asset and the share $(1-x)$ of the risk-free asset. In this general representation, D is bounded from above with $\overline{D}$, which is different in monopolistic and competitive cases as discussed below.[19] In node 2, nature determines the state "H" or "L". The risky asset yields the rate of return r^H in the state of nature "H", which appears with the probability p, and r^L otherwise. The risk-free asset returns r^F in any state of nature. The control variables for bankers are D and x. Since the action space for the bankers is a two-dimensional continuum in (x, D)-space, the lower and upper limits for both variables are placed at the bottom and top of the arc joining two edges protruding from the decision node 1. The infinite number of resulting decision nodes 2 are represented by a single node placed in the centre of the arc. Since an insolvent bank is liquidated, its payoff is zero if the value of its portfolio is less than the total liabilities, which is represented by a $\max$-function.

Since the Regulator is committed to liquidate the bank in the case of insolvency, the profit of the bank in the state of nature s $\in \{H, L\}$ is

$$\Pi^{\mathbf{s}} = \max\left[\left(xr^{\mathbf{s}} + (1-x)\,r^F - r^D\right)D; 0\right]$$

[19] Moreover, in the monopolistic case, the bankers can also choose the interest rate on deposits. I will come back to this issue in the relevant subsection.

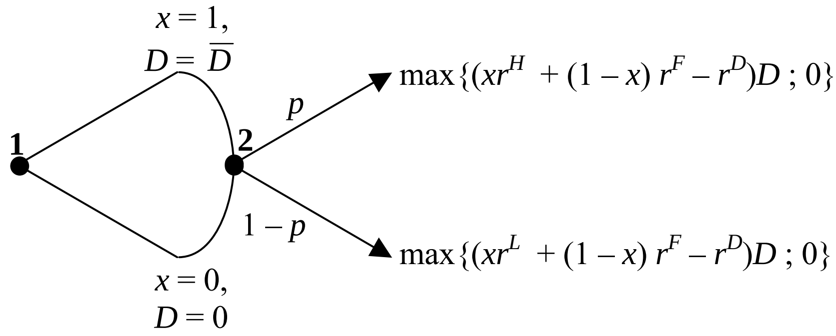

Figure 2.3. Decision-tree of a bank

Hence, the expected profit of the bank is given by

$$\Pi^e = p \max\left[\left(xr^H + (1-x)\, r^F - r^D\right) D; 0\right] \\ + (1-p) \max\left[\left(xr^L + (1-x)\, r^F - r^D\right) D; 0\right] \tag{3}$$

The bankers solve the following optimization problem:

$$\begin{array}{ll} \Pi^e & \rightarrow \max\limits_{x,D} \\ \text{s.t.} & 0 \leq x \leq 1 \\ & D \geq 0 \end{array}$$

The solution of this optimisation problem determines the demand for deposits D^d and the optimal share of the risky asset x^* in the bank's portfolio.

2.3.2 Insolvency Resolution

The value of the bank is the value of its portfolio, which is state-contingent. If the "H"-state of nature is realized in the second period, the value V^H of the bank

$$V^H = \left[x\left(1 + r^H\right) + (1-x)\left(1 + r^F\right)\right] D^d$$

If the "L"-state of nature is realized, the value V^L of the bank is

$$V^L = \left[x\left(1 + r^L\right) + (1-x)\left(1 + r^F\right)\right] D^d$$

The bank is solvent in the state of nature s if and only if its value $V^{\mathbf{s}}$ is not less than its obligations:

$$V^{\mathbf{s}} \geq \left(1 + r^D\right) D^d$$

If the bank is insolvent, the insolvency resolution procedure takes place. The case of the insolvency resolution through the liquidation of the bank is considered first, while the bailout rule, which may be an alternative to the liquidation, is introduced later in the text.

In case of the bank's insolvency, depositors cannot be repaid in full since $\left(1 + r^D\right) D^d > V^{\mathbf{s}}$. The insolvency resolution procedure (liquidation of the bank) guarantees each depositor to receive $\frac{V^{\mathbf{s}}}{D^d}$ on each unit of the initial deposit. We can calculate the state-contingent rate of return which a depositor faces in case of the bank's insolvency. In this case, the households obtain the value of the bank. The state-contingent rate of return $\widetilde{r}^{\mathbf{s}}$ ($\mathbf{s} = H, L$) is exactly the rate of return of the bank's financial portfolio with the share x of the risky asset and $(1 - x)$ of the risk-free asset:

$$\begin{array}{ll} \widetilde{r}^H = xr^H + (1 - x)\, r^F & \text{if } \ \text{"H"-state} \\ \widetilde{r}^L = xr^L + (1 - x)\, r^F & \text{if } \ \text{"L"-state} \end{array} \tag{2.4}$$

Consider now the probability ρ of the event that the depositors are paid in full. This probability obviously depends on the bank's portfolio composition x. Moreover, it depends on the interest rate r^D on deposits. The following Lemma establishes the relationship between the variables.

Lemma 2.1 Given the parameters r^H, r^F, r^L and p, the probability ρ is a function of r^D and x:

$$\rho\left(x; r^D\right) = \begin{cases} 0 & \text{if} \quad r^D > \widetilde{r}^H \\ p & \text{if} \quad \widetilde{r}^H \geq r^D > \widetilde{r}^L \\ 1 & \text{if} \quad r^D \leq \widetilde{r}^L \end{cases} \tag{2.5}$$

The intuition behind the Lemma is obvious. If the deposit interest rate is so high that it exceeds the best possible outcome for the bank, i.e. $r^D > xr^H + (1 - x)r^F$, then the bank will never be able to repay the deposits in full. If the deposit interest rate is so low that it never exceeds the worst possible outcome for the bank, i.e. $r^D \leq xr^L + (1 - x)r^F$, then the bank will always be able to fulfill its obligation and the deposits are repaid in full with the probability of 1. Otherwise, the deposits are paid in full only in case of the "high" state of nature, and probability of that is p.

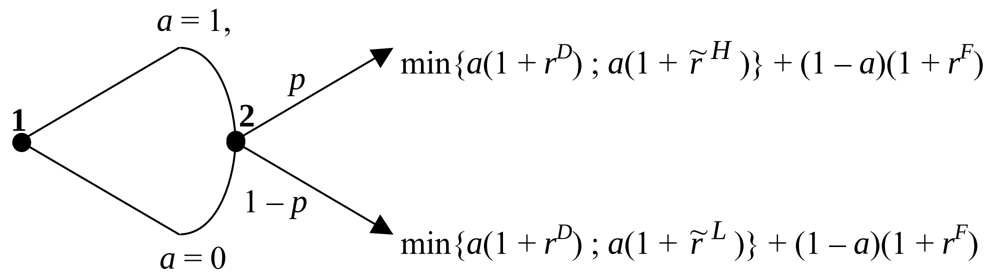

Figure 2.4. Intermediated economy: decision-tree of households.

2.3.3 Households

The households have to decide, whether to invest their unit endowment into the safe asset, into the deposit, or combine them in a portfolio with share a of deposits and $(1-a)$ of safe assets.

The decision-tree of households is depicted in Figure **??**. In node 1, the households decide upon the share of deposits $a \in [0;1]$ in their portfolios. The rest is invested in the risk-free asset. In node 2, the state of the nature is determined: the state "H" occurs with probability p, the state "L" occurs with probability $(1-p)$. In both states of nature, the risk-free asset yields the rate of return r^F, which results for households in the payoff of $(1-a)\left(1+r^F\right)$. The payoff on deposits is state-contingent. If the bank is solvent, the households obtain their deposit repayment $a\left(1+r^D\right)$ in full. If the value of the bank is below its liabilities, households receive only the rate of return $\widetilde{r}^H$ or $\widetilde{r}^L$ depending on the state of the nature. The explanation of the graphical representation is the same as for Figure **??**.

The bank is insolvent in the state of nature s if its value is below that of its liabilities $V^{\mathrm{s}} < \left(1+r^D\right)D$, where D is the total amount of deposits in the bank. Since in case of the bank's insolvency each depositor receives the gross rate of return $1+\widetilde{r}^{\mathrm{s}} = \frac{V^{\mathrm{s}}}{D}$, the insolvency condition is equivalent to $\widetilde{r}^{\mathrm{s}} < r^D$. This allows one to represent the state-contingent deposit payoff G^{s} to households with help of the $\min$-function:

$$G^{\mathrm{s}} = \min\left\{a\left(1+r^D\right); a\left(1+\widetilde{r}^{\mathrm{s}}\right)\right\} + (1-a)\left(1+r^F\right)$$

Hence, the expected deposit payoff to households is

$$\begin{aligned} G^e &= p \min \left\{ a \left(1 + r^D\right); a \left(1 + \widetilde{r}^H\right) \right\} + \\ & \quad (1 - p) \min \left\{ a \left(1 + r^D\right); a \left(1 + \widetilde{r}^L\right) \right\} + (1 - a) \left(1 + r^F\right) \end{aligned} \tag{2.6}$$

Remember the households are assumed to be shareholders of the bank. If the bank is solvent, households obtain a positive dividend payment δ^{s} in the state of nature s. Note that the dividend δ^{s} is state-contingent, since the profit of the bank (if positive) depends on the state of nature s.

Since G^e describes only the deposit payoff, one now has to take the dividend δ^{s} (if any) paid to shareholders into account. Remember that the state-contingent profit of the bank already accounts for the solvency issue, since it is only positive if the bank is solvent. Hence, given that the dividend payment δ^{s} is a share of the bank's profit, it is only positive if the bank is solvent. In general, risk-neutral households should solve the following maximization problem:

$$\begin{aligned} G^e + p\delta^H + (1 - p)\,\delta^L \quad &\rightarrow \quad \max_a \\ \text{s.t.} \quad & \quad 0 \leq a \leq 1 \end{aligned} \tag{2.7}$$

The state-contingent dividend payment δ^{s} depends, of course, on the decisions of the bank and on the deposit interest rate r^D. Recall that the bank's and households' decisions are separate, and that the households perceive the dividend component of their welfare in period 2 as exogenously given. Therefore, the optimization problem (**??**) has the same solution as the problem

$$\begin{aligned} G^e \quad &\rightarrow \quad \max_a \\ \text{s.t.} \quad & \quad 0 \leq a \leq 1 \end{aligned} \tag{2.8}$$

This optimization problem determines the optimal share a^* of deposits in the portfolio of households. Remember also that all households are distributed on the interval $[0; 1]$ and each one possesses a unit endowment. Total (aggregate) supply of deposits in the economy is then

$$D^s = \int_0^1 a^* di = a^* \tag{2.9}$$

2.3.4 Supply of Deposits

Total supply of deposits is defined by (**??**) and determined by the choice of households regarding the share of deposits a in their portfolios. Note that $\widetilde{r}^H \geq \widetilde{r}^L$, and we can consider the same three cases as in Lemma **??**. The expected deposit payoff (**??**) can be reformulated:

$$G^e = \begin{cases} 1 + a\left(p\widetilde{r}^H + (1-p)\,\widetilde{r}^L\right) + (1-a)\,r^F & \text{if} \quad r^D > \widetilde{r}^H \\ 1 + a\left[pr^D + (1-p)\,\widetilde{r}^L\right] + (1-a)\,r^F & \text{if} \quad \widetilde{r}^L < r^D \leq \widetilde{r}^H \\ 1 + ar^D + (1-a)\,r^F & \text{if} \quad r^D \leq \widetilde{r}^L \end{cases} \tag{2.10}$$

Note that this is a well-defined expected payoff function, since the information regarding x, r^H, r^L, r^F and any value of r^D defines exactly one expression on the right-hand side of (**??**). Therefore, G^e is unambigously determined by the probability p and the control variable of the households a.

Note as well that

$$p\widetilde{r}^H + (1-p)\,\widetilde{r}^L = x\left(pr^H + (1-p)\,r^L\right) + (1-x)\,r^F$$

represents the expected rate of return on the bank's portfolio.

The formula (**??**) interprets the expected payoff of the households in the same way as Lemma **??** treats the probability that the households are paid in full, namely by distinguishing between the three possible situations. To begin with, if the deposit interest rate is higher than the best possible rate of return on the bank's portfolio[20], then the bank is always insolvent and the expected payoff to households is determined by the expected rate of return on the banks financial portfolio. Secondly, if the deposit interest rate is lower than the worst possible outcome for the bank's portfolio, then the bank is always solvent, and depositors are paid in full. Finally, if the deposit interest rate is between these two extremes, then depositors are repaid in full with probability p and obtain the liquidation value of the bank with probability $(1-p)$.

To derive the supply of deposits, I make an additional assumption: if the expected deposit payoff is exactly equal to the risk-free return, then the households still prefer the deposit contract:

$$\text{if } G^e = r^F \text{ then } a^* = 1 \tag{A-2-3}$$

[20] Remember that the portfolio is fixed through the choice of x.

A possible interpretation of this assumption could be infinitesimal costs, induced by a purchase of the risk-free asset. Such costs cannot be the obstacle for the households to access the market for the risk-free asset, but are sufficient to influence their decision in case of equal values of G^e and r^F, since the deposit contract is completely free of costs. Another interpretation could be seen in the assumption that the households are shareholders of the banks and therefore prefer a contract with the bank, e.g. due to psychological reasons, if it does not lead to a smaller payoff than the purchase of the risk-free asset.

Proposition 2.1 *Aggregate deposit supply is given by the function*

$$D^s\left(r^D, x\right) = \begin{cases} 1 & \textit{if} \quad r^D \geq r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right) \\ 0 & \textit{if} \quad r^D < r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right) \end{cases} \tag{2.11}$$

Proposition **??** determines the deposit supply function. A possible interpretation of the expression (**??**) is that the households require a positive **interest rate difference** $r^D - r^F = \frac{(1-p)}{p} x \left(r^F - r^L\right) > 0$ above the risk-free rate in order to decide to buy a deposit contract. Remember that there is no asymmetry in information regarding the composition of the bank's portfolio. If the bank does not invest in the risky asset ($x = 0$), the interest rate difference is zero since deposit contracts are effectively risk-free. If there is no uncertainty in the economy, and only high state of nature can be realized ($p = 1$), then the difference is again zero. If only the low state of the nature is possible ($p = 0$) the expression (**??**) is undefined, which can be seen as though the households require an infinitely high difference. The reason for this is that by assumption (both **??** and **??**) $r^F > r^L$ and, hence, depositors would strongly prefer the risk-free asset.

It should be noted that the interest rate difference $\frac{(1-p)}{p} x \left(r^F - r^L\right)$ is *not* a **risk premium**, which is commonly defined in the theory of finance as the difference between the *expected* return on an asset and the risk-free return. The risk premium for risk-neutral agents is always zero. It is easy to check that the *expected* return on deposits is exactly equal to the risk-free rate as soon as $r^D = r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$, which implies a zero risk premium (this can be seen from the proof of Proposition **??**, see Appendix **??**).

Aggregate deposit supply is depicted in Figure **??**. It is zero if the deposit interest rate is low ($r^D < r^F + \frac{1-p}{p} x \left(r^F - r^L\right)$) und is equal to unity as soon as the deposit interest

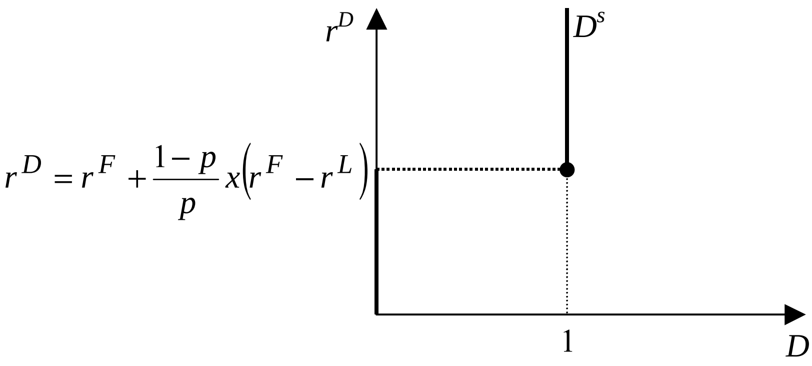

Figure 2.5. Aggregate deposit supply

rate reaches the values $r^D \geq r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$. Remember that it was assumed that households still prefer the deposit contract to the risk-free asset in case of equality. This explains the "jump" in the deposit supply.

Now that the supply of deposits is determined, one may proceed with the study of monopolistic and competitive demands for deposits in the banking sector as well as their related equilibria.

2.3.5 Monopolistic Equilibrium

Consider now a banking sector which consists of a single monopolistic bank. Since the Regulator is committed to liquidating the bank in case of insolvency, the expected profit of the bank is given by (**??**):

$$\begin{aligned} \Pi^e &= p \max \left[\left(x r^H + (1-x) r^F - r^D \right) D; 0 \right] + \\ &+ (1-p) \max \left[\left(x r^L + (1-x) r^F - r^D \right) D; 0 \right] \end{aligned} \tag{2.12}$$

Recall that the bankers maximize the wealth of the bank's shareholders. The monopolistic bank is the price-maker in the market for deposits, and uses r^D as a control variable. At the same time, the monopolistic bank determines both its portfolio composition x as well as the optimal amount of deposits D to be collected. Obviously, the monopolistic bank cannot collect more deposits than the households supply, therefore $D \leq D^s \left(r^D, x\right)$. On the other hand, the amount of collected deposits cannot be negative due to the assumption that the short sales with financial assets are not allowed. Indeed, this assumption implies that $0 \leq x \leq 1$, and hence the assets-side of the bank's balance sheet is non-negative, which further implies that $D \geq 0$. These considerations allow one to formulate the following optimization problem for the monopolistic bank:

$$\begin{aligned} \Pi^e \quad &\rightarrow \quad \max_{x,D,r^D} \\ \text{s.t.} \quad & \quad 0 \leq x \leq 1 \\ & \quad 0 \leq D \leq D^s\left(r^D, x\right) \end{aligned} \tag{2.13}$$

where $D^s\left(r^D, x\right)$ is given by (**??**).

The solution of the maximisatioin problem (**??**) results in the share of the risky asset in the bank's portfolio x^*, the interest rate on deposits r^D_m, and the bank's demand for deposits D^d. The result is summarized in the following proposition, which is proven in the Appendix **??**.

Proposition 2.2 *Optimal choice of the monopolist bank under the commitment of the Regulator to liquidate the bank in case of its insolvency, is $x = 1$ and $r^D_m = r^F + \frac{1-p}{p}\left(r^F - r^L\right)$. The bank collects as much deposits as is supplied at the interest rate r^D_m: $D^d = D^s\left(r^D_m, x^*\right)$.*

The proposition ensures that a monopolistic bank would invest the whole amount of deposits collected in the risky asset. The demand for the risky asset in an economy with a monopolistic banking sector is given by $X = x^* D^s\left(r^D_m, x^*\right)$. Recall that in the market equilibrium (Corrolary **??**), the households invested their whole endowment into the risky asset. The monopolistic bank would replicate the allocation of the market equilibrium, if, and only if, the households invest their whole endowment into the deposit contract. To analyze this, we need to analyze the equilibrium in the deposit market.

Definition 2.2 Monopolistic equilibrium under parameters $\left(p; r^F; r^H; r^L\right)$ is a tuple (X^*, D^*, r^D_m), which provides

(1) $X^* = x^* D^d\left(r^D_m, x^*\right)$ with $(x^*; D^d; r^D_m) \in \arg\max \Pi^e$

(2) $D^s(r^D_m; x^*) = a^* \in \arg\max G^e$

(3) $D^* = D^d\left(r^D_m, x^*\right) = D^s(r^D_m; x^*)$

The definition of equilibrium requires that both actors (the bank and the households) are in their respective optima. The optimal choice of a^* by households determines the supply of deposits $D^s(r_m^D; x^*)$, which depends on the optimal choice of the bank. The optimal choice of r_m^D by the bank and its choice of the portfolio composition x^* determine the bank's demand for deposits $D^d\left(r_m^D, x^*\right)$. If the demand D^d and the supply D^s are equal, we have deposit market equilibrium with the amount of deposits in the bank D^*. Moreover, the choice of x^* by the bank determines its demand for the risky asset $X = x^* D^*$, which in equilibrium is the aggregate amount of funds X^* invested in the risky asset.

Proposition 2.3 *If the Regulator commits to liquidate the bank in case of insolvency, the monopolistic equilibrium in the model is unique and given by*

$$\begin{array}{l} X^* = 1 \\ D^* = 1 \\ r_m^D = r^F + \frac{1-p}{p}\left(r^F - r^L\right) \end{array} \tag{2.14}$$

Proposition **??** is the basis for the comparison of the intermediated economy with the market one. A monopolistic bank provides the same allocation of funds as the market economy, namely that the whole endowment of the households is invested in the risky asset (see Corollary **??**). Furthermore, the interest rate offered by the monopolistic bank on deposits is equal to the risk-free rate if there is no uncertainty and the "H"-state of nature is realized with a probability of $p = 1$. Otherwise, the deposit interest rate is strictly above the risk-free rate, but is always below r^H. Assumption **??** guarantees that the probability of the "H"-state of nature is non-zero, otherwise it contradicts to the Assumption **??**. If p is small but non-zero ($p > \varepsilon \to +0$), the the rate of return r^H is sufficiently high to make the expected rate of return on the risky asset higher than the risk-free rate (due to **??**). This implies

$$r^H > \frac{1}{p}\left(r^F - (1-p)\, r^L\right) = r_m^D \tag{2.15}$$

and hence the deposit interest rate is always below r^H.

The expected rate of deposit return is equal to the risk-free rate. However, the households obtain the profit of the bank as shareholders so that their state-contingent wealth is the same as in the case of market equilibrium. As soon as the assumption of all households being shareholders of the bank in equal shares is violated, there appears a welfare gap between the shareholders and non-shareholders.

2.3.6 Competitive Equilibrium

Now consider a banking sector with an infinite number of identical and competitive banks distributed on the interval $[0;1]$. All the banks are identical.

The expected profit of each bank given the regulators commitment to close insolvent banks is identical to the monopolistic bank (**??**):

$$\begin{aligned}\Pi^e &= p\max\left[\left(xr^H+(1-x)\,r^F-r^D\right)D;0\right]+\\ &\quad +(1-p)\max\left[\left(xr^L+(1-x)\,r^F-r^D\right)D;0\right]\end{aligned}$$

Due to the atomicity of banks, no individual bank can influence the deposit interest rate.

$$\begin{aligned}\Pi^e &\rightarrow \max_{x,D} \\ \text{s.t. } D &\geq 0 \\ 0 &\leq x\leq 1\end{aligned} \tag{2.16}$$

To find the solution that determines the demand for deposits $D^d = D^d\left(r^D,x\right)$, we rearrange the banks' expected profit function:

$$\Pi^e=\begin{cases} 0 & \text{if } \quad r^D>\widetilde{r}^H \\ p\left(xr^H+(1-x)\,r^F-r^D\right)D & \text{if } \widetilde{r}^L<r^D\leq\widetilde{r}^H \\ \left[x\left(pr^H+(1-p)\,r^L\right)+(1-x)\,r^F-r^D\right]D & \text{if } \quad r^D\leq\widetilde{r}^L \end{cases}$$

The solution of the maximisation problem (**??**) determines the demand of each bank for deposits D^d as well as the optimal share of the risky asset x^* in the bank's portfolio. Both depend on the deposit interest rate r^D, as stated in the following proposition:

Proposition 2.4 *Under competition in banking sector and under commitment of the Regulator to liquidate insolvent banks, the demand of an individual bank for deposits D^* and the composition of the bank's financial portfolio x^* are given by the correspondences*

$$D^*\left(r^D\right) \in \begin{cases} [0,\infty) & \text{if } r^D\geq r^H \\ \{\infty\} & \text{if } r^D<r^H \end{cases} \tag{2.17}$$

$$x^*\left(r^D\right) \in \begin{cases} [0;1] & \text{if } r^D\geq r^H \\ \{1\} & \text{if } r^D<r^H \end{cases} \tag{2.18}$$

The intuition behind the proposition is straightforward. If the interest rate on deposits, which any individual bank perceives as an exogenous parameter, is higher than the highest possible return on the bank's financial portfolio, then the bank is insolvent in any state of the nature in the second period and its expected profit is zero, no matter what x and D the

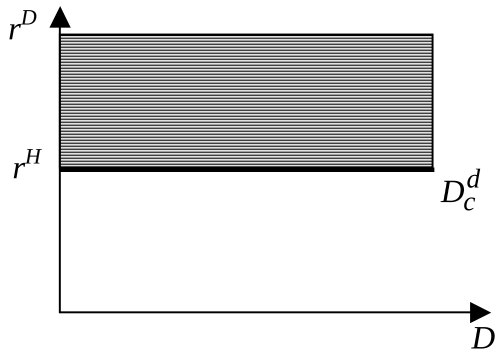

Figure 2.6. Aggregate deposit demand under competition in the banking sector: regulator commits to liquidation.

bank chooses. The same holds if $r^D = r^H$, in which case the bank may still be solvent in the "H"-state of nature, but its state-contingent profit as well as the expected profit is zero.

If the deposit interest rate enables a positive profit in at least in one state of the nature ($r^D < r^H$), then the expected profit of the bank is strictly positive: it is positive if the bank is solvent (with a positive probability) and it is zero if the bank is liquidated in case of insolvency. Each bank would maximize its expected profit, which positively depends on both x and D. Hence the choice of the highest possible x and D is optimal. Since x is bounded, the bank chooses its upper limit $x^* = 1$. Since D has no upper limit in the optimization problem, the demand of the bank for deposits is theoretically infinite. In other words, if the deposit interest rate is low enough ($r^D < r^H$), no finite amount of deposits $\overline{D}$ is optimal for the bank, since any higher amount of deposits $\widehat{D} > \overline{D}$ increases the bank's expected profit. This implies that the demand of an individual bank for deposits is absolutely elastic at the interest rate $r^D = r^H$.

Remember that we consider a continuum of identical banks distributed at $[0; 1]$. The aggregate demand for deposits D_c^d in the competitive banking sector is then numerically equal to the demand of an individual bank:

$$D_c^d = \int_0^1 D^* di = D^*$$

Aggregate deposit demand in the competitive case is presented in Figure **??**. The striped area corresponds to the banks' indifference regarding their choice of D if the deposit interest

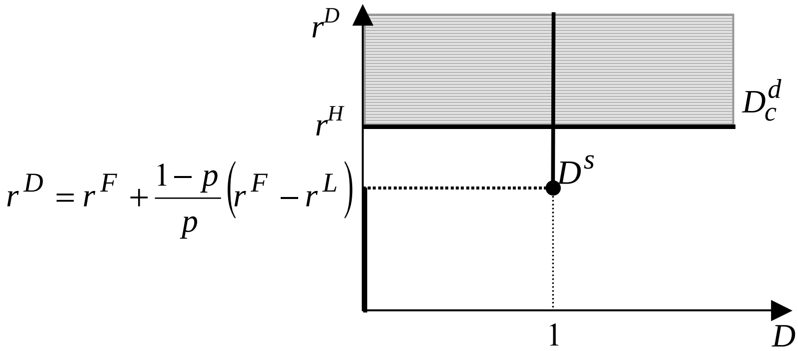

Figure 2.7. Deposit market equilibrium: competitive banking sector.

rate is excessively high ($r^D \geq r^H$).

We can now find the equilibrium for the case of a competitive banking sector with a Regulator committed to liquidating any insolvent bank.

Definition 2.3 Competitive equilibrium under parameters $\left(p; r^F; r^H; r^L\right)$ is a tuple $(X^*, D^*,$ $r_c^D)$, which provides

(1) $X^* = x^* D^d$ with $\left(x^*\left(r_c^D\right), D^d\left(r_c^D\right)\right) \in \arg\max \Pi^e$

(2) $D^s\left(r_c^D, x^*\right) = a^* \in \arg\max G^e$

(3) $D^* = D^s\left(r_c^D, x^*\right) = D^d\left(r_c^D\right)$

As in the monopolistic equilibrium, this definition presumes that both banks and households are in their respective optima with regards to the choice of the portfolio composition x^* and deposit demand D^d by the banks, and of the deposit supply D^s by the households. As soon as the interest rate $r^D = r_c^D$ provides the equality between the deposit supply (given the choice of the banks with respect to x^*) and the demand for deposits at the level of D^*, the deposit market is in equilibrium. Simultaneously, the share x^* of the risky assets in banks' financial portfolios is determined, which yields the aggregate equilibrium investment in the risky asset $X^* = x^* D^*$.

The deposit market equilibrium in case of competitive banking sector is illustrated in Figure **??**. Note that $r^F + \frac{1-p}{p}\left(r^F - r^L\right) < r^H$ due to (**??**). If the deposit interest rate is higher than r^H, the banks are indifferent with respect to the total value of deposits, since the expected profit of the banks is zero and does not depend on the amount of deposits.

As soon as the deposit interest rate is below r^H, the expected profit of the banks depend positively on the amount of deposits, which induces infinitely high demand for deposits. In equilibrium, the deposit rate can take any value above or equal r^H, and the equilibrium amount of deposits is determined by the supply of deposits. Since equilibrium deposit rate is not uniquely determined, infinitely many equilibria can exist.

Proposition 2.5 *If the Regulator is committed to liquidate insolvent banks, there exist multiple competitive equilibria given by:*

$$\begin{array}{l} X^* \in [0;1] \\ D^* = 1 \\ r_c^D \geq r^H \end{array} \tag{2.19}$$

According to Lemma **??**, the only equilibrium with a positive probability ρ, with which depositors obtain deposit repayments in full, is the one with $x^* = 1$ and $r_c^D = r^H$ (under these conditions $\rho = p$). Otherwise $\rho = 0$, , which means that the depositors are never repaid on their deposits in full. This is due to the fact that the bank cannot obtain sufficient return on its portfolio to be able to pay that high interest on deposits. Still, the supply of deposits is equal to one, since depositors expect to obtain the liquidation value of the bank. The expected return on deposits in this case is not less than the return on the safe asset (due to assumption **??**).

Note also that the competition does not necessarily lead to an infinitely high deposit interest rate. In a competition à la Bertrand, the price war would even stop as soon as the deposit interest rate achieves the level of r^H, since no bank would have incentives to set a higher interest rate, because this would not increase the expected profit. In any case, the deposit interest rate is higher that the expected rate of return on the risky asset. A similar result is known from Matutes and Vives (2000), who write, "when competition is intense banks tend to set deposit rates too high... With perfect competition rates are excessive." Matutes and Vives (2000) attribute this effect to the fact that the banks do not internalise the cost of failure. The same happens above in the world, where the Regulator is committed to liquidate insolvent banks. The commitment to the liquidation implies limited liability of the banks. The worst outcome for the banks, which act in the interest of their shareholders, is in this case to obtain zero profit and to pay zero dividend to the shareholders.

Corollary 2.2 *If the Regulator commits to liquidate insolvent banks, the intermediated economy replicates the allocation of the market equilibrium with the expected return on deposits at the risk-free rate in the case of monopolistic banking sector, and leads to an excessively high deposit rate and to the indeterminacy with respect to the risky investment in the case of competitive banking sector*

2.4 Intermediated Economy: Ambigous Bailouts

Now consider the world in which the Regulator does not commit to liquidate insolvent banks. In this case depositors and bankers can differ in their beliefs with respect to the failure resolution. In the following text, I focus on the case of a special asymmetry in the beliefs: depositors expect an insolvent bank to be liquidated, but the bank expects that the liquidation procedure will not take place. In other words, depositors count on the limited liability of the bank, as above, which means they expect to obtain in total not more than the total value of the bank's assets in case of insolvency of the bank. On the contrary, the bank counts on its unlimited liability, which means it assumes to repay deposits in full even in case of insolvency.[21]

Unlimited liability of the bank means the bank can end with a negative net worth. In the two-period setting here, this is rather a *hypothetical* case. However, remember the bank was assumed to maximize the expected wealth of its shareholders (Section **??**). This gives rise to a possible interpretation of unlimited liability[22] if a bailout of an insolvent bank is organized as described below.[23]

2.4.1 Bailout and Decision-Making

Assume there exists a Regulator who subsidizes the bank in case of its insolvency. To do this, the Regulator collects taxes from the population in the second period *after* the insolvency of the bank is realized. Note that in the model, the only taxpayers are depositors, who

[21] I discuss the concepts of limited liability and unlimited liability and their relation to bailouts and liquidation in the next Chapter in more details.
[22] Effectively, it is unlimited liability of the shareholders of the bank, not of the bank itself.
[23] Another interpretation for the negative net worth of the bank could be seen in a dynamic setting, in which the bank could end one period with losses, but still be able to fully repay the deposits of the previous period out of the newly made deposits in the current period by new depositors. I present a simple example of such a dynamic setting in the next chapter.

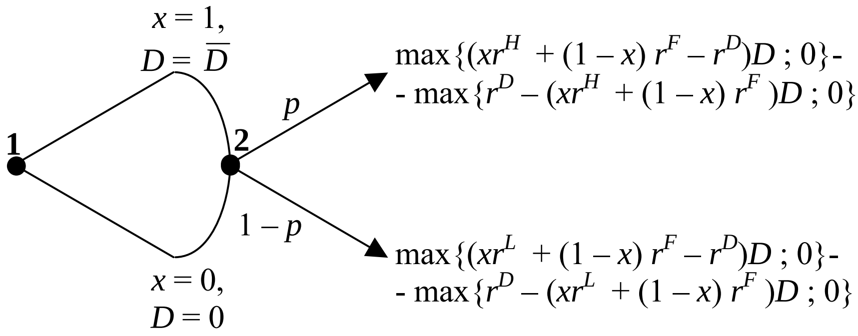

Figure 2.8. Decision-making by a bank: a bank takes possible costs of bailout bourne by the bank's shareholders into account.

are at the same time the shareholders of the banks.

If a bank is insolvent, the shareholders pay the regultor taxes[24] in total amount of $\theta^{\mathbf{s}} = \max\left\{\left[r^D - \left(xr^{\mathbf{s}} + (1-x)\, r^F\right)\right] D; 0\right\}$. Note that $\theta^{\mathbf{s}}$ is state-contingent ($\mathbf{s} \in \{H, L\}$), moreover, it is positive only if the bank is insolvent, and it is zero otherwise.

If in the state of nature $\mathbf{s} \in \{H, L\}$ the bank is solvent, it pays its profit to the shareholders as the dividend in total amount of

$$\delta^{\mathbf{s}} = \max\left[\left(xr^{\mathbf{s}} + (1-x)\, r^F - r^D\right) D; 0\right]$$

If the bank is insolvent ($xr^{\mathbf{s}} + (1-x)\, r^F < r^D$), the state-contingent payoff to the shareholders is zero.

The decision-making of the bank in case of such bailout is presented in Figure **??**. The only difference arises through the fact that now, in the case of insolvency, the bank is not liquidated, but is rather bailed out, and the costs of the bailout are borne by its shareholders. The bank takes these costs into account in its decision-making.

[24] In the formulation of the model, the households have invested the whole endowment either in the deposit contract or in a risk-free asset so that they do not possess extra funds to pay taxes before they obtain returns from their investment. However, it was not assumed that the unit endowment was the only wealth of the households; it was only assumed that it was an endowment dedicated to the investment. Hence, it may be seen as though households have additional funds in excess of the unit investment endowment and that these funds are used to pay taxes, with the same net effect on the households' wealth as in the text. Another interpretation could be a promise of the households to pay taxes after they obtain investment return. In such a case, the regulator *advances* a certain amount of funds to bail the banks out, and collects this amount as taxes *after* the bailouts have taken place and the households obtain investment returns. Since both actions take place in one period, the net effect within the period is exactly the one described in the text, and there is no need to explicitly model the tax procedure.

Since the bank maximizes the expected profit of its shareholders, its state-contingent objective is now

$$\begin{aligned}
\delta^{\mathbf{s}} - \theta^{\mathbf{s}} &= \\
&= \max\left\{\left(xr^{\mathbf{s}} + (1-x)\,r^F - r^D\right)D; 0\right\} - \max\left\{\left[r^D - \left(xr^{\mathbf{s}} + (1-x)\,r^F\right)\right]D; 0\right\} = \\
&= \left(xr^{\mathbf{s}} + (1-x)\,r^F - r^D\right)D
\end{aligned}$$

In terms of expectations, the objective function of the bank is

$$\begin{aligned}
\Pi^e &= p\left(\delta^H - \theta^H\right) + (1-p)\left(\delta^L - \theta^L\right) = \\
&= \left[x\left(pr^H + (1-p)\,r^L\right) + (1-x)\,r^F - r^D\right]D \qquad (2.20)
\end{aligned}$$

I prefer to use the same notation for the objective function of the bank as for the expected profit of the bank before.[25]

The decision-making by households is unchanged, as depicted in Figure **??**. Indeed, since the bailout policy of the Regulator is ambiguous, depositors have no information with regards to the treatment of failing banks. In contrast to the banks, depositors expect a failing bank to be liquidated. Therefore they do not count on any bailout costs in their expected profit function G^e. Hence, the decision-making by households is the same as in Section **??**, and the resulting deposit supply function repeats (**??**):

$$D^s\left(r^D, x\right) = \begin{cases} 1 & \text{if } \; r^D \geq r^F + \frac{(1-p)}{p}x\left(r^F - r^L\right) \\ 0 & \text{if } \; r^D < r^F + \frac{(1-p)}{p}x\left(r^F - r^L\right) \end{cases} \qquad (2.10)$$

2.4.2 Monopolistic Equilibrium

Consider now a monopolist bank, which expects to be bailed out in case of insolvency, as described above. The bank maximizes the expected profit of its shareholders:

$$\begin{aligned}
\Pi^e &= \left[x\left(pr^H + (1-p)\,r^L\right) + (1-x)\,r^F - r^D\right]D \to \max_{x,D,r^D} \\
\text{s.t.} \quad & 0 \leq x \leq 1 \\
& 0 \leq D \leq D^s\left(r^D, x\right)
\end{aligned}$$

25 The same target function of the bank would appear in the case where the shareholders of the bank subsidize the bank directly instead of through the tax system. However in such case it would be more difficult to justify the asymmetry in beliefs with regard to bailouts.

where $D^s\left(r^D, x\right)$ is given by (**??**).

Proposition 2.6 *If the monopolistic bank expects to be bailed out at costs of its shareholders, and maximizes the expected profit of the shareholders, its optimal choice* $\left(x^*, D^*, r_m^D\right)$ *is*

$$
\begin{aligned}
x^* &\in \begin{cases} \{1\} & \text{if } \; p^2 > \frac{r^F - r^L}{r^H - r^L} \\ [0,1] & \text{if } \; p^2 = \frac{r^F - r^L}{r^H - r^L} \\ \{0\} & \text{if } \; p^2 < \frac{r^F - r^L}{r^H - r^L} \end{cases} \\
D^* &\in \begin{cases} \{1\} & \text{if } \; p^2 > \frac{r^F - r^L}{r^H - r^L} \\ [0,1] & \text{if } \; p^2 \leq \frac{r^F - r^L}{r^H - r^L} \end{cases} \\
r_m^D &= \begin{cases} r^F + \frac{(1-p)}{p}\left(r^F - r^L\right) & \text{if } \; p^2 > \frac{r^F - r^L}{r^H - r^L} \\ r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right) & \text{if } \; p^2 = \frac{r^F - r^L}{r^H - r^L} \\ r^F & \text{if } \; p^2 < \frac{r^F - r^L}{r^H - r^L} \end{cases}
\end{aligned}
$$

In contrast to the previous case, in which the Regulator was committed to liquidation, the bank now internalises the costs of bailout, since it is concerned about the wealth of its shareholders. Indeed, under ambiguous bailouts the bank expects the Regulator to subsidize the bank, but the source of such a subsidy are the taxes collected from the shareholders of the bank. In order to maximize the expected wealth of the shareholders, the bank follows a more cautious strategy than in the case in which the Regulator is committed to the liquidation of a failing bank.

To highlight the cautionary character of the bank's choice, it suffices to compare the Propositions **??** and **??**. When the Regulator was commited to liquidation, the optimal choice of the bank was to set the deposit rate at the lowest possible level $r_m^D = r^F + \frac{1-p}{p}\left(r^F - r^L\right)$, which would allow to collect the highest possible amount of deposits $D^* = 1$, and to invest them completely in the risky asset ($x^* = 1$). As soon as the bank internalizes the bailout costs, which are borne by its shareholders, its choice depends on the relative riskiness of the risky asset compared to the risk-free one. If the probability of success for the risky investment project is high enough ($p > \sqrt{\frac{r^F - r^L}{r^H - r^L}}$), the choice of the monopolistic banks repeats that in the commitment case. However, if the probability of success for the risky investment is low enough, the choice of the monopolistic bank exhibits caution: the bank chooses to invest only in the risk-free asset ($x^* = 0$) and sets the deposit interest rate at the risk-free level ($r_m^D = r^F$). At the same time, this caution makes the bank indifferent with respect to the level of deposits ($D^* \in [0,1]$), since the expected profit of the bank's shareholders is in this case zero.

Whether the probability of success is high enough, depends not only on the absolute value of the probability p, but also on the values of r^H, r^F and r^L. In one economy with the probability of success p_1, the monopolist bank may opt invest in a risk-free manner although in another economy with the probability of success p_2 the monopolist bank opts to invest riskily even if $p_1 > p_2$. It is possible if, for example, the rate r_2^H in the second economy is sufficiently high (relative to r_2^F and r_2^L) to make the expected profit of the shareholders of the bank positive (this is guaranteed by the condition $p_2 > \sqrt{\frac{r_2^F - r_2^L}{r_2^H - r_2^L}}$), whereas in the first economy it is sufficiently small to make this expected profit negative ($\sqrt{\frac{r_2^F - r_2^L}{r_2^H - r_2^L}} < p_2 < p_1 < \sqrt{\frac{r_1^F - r_1^L}{r_1^H - r_1^L}}$).

The following proposition describes the monopolistic equilibrium in accordance with Definition **??**.

Proposition 2.7 *Assume that the monopolistic bank expects to be bailed out in the case of insolvency at costs of its shareholders, and maximizes the expected profit of the shareholders. Assume that depositors expect an insolvent bank to be liquidated. Under these assumptions, the monopolistic equilibrium in the model is given by:*

$$
\begin{aligned}
X^* &\in \begin{cases} \{1\} & \textit{if} \;\; p^2 > \frac{r^F - r^L}{r^H - r^L} \\ [0,1] & \textit{if} \;\; p^2 = \frac{r^F - r^L}{r^H - r^L} \\ \{0\} & \textit{if} \;\; p^2 < \frac{r^F - r^L}{r^H - r^L} \end{cases} \\
D^* &= 1 \\
r_m^D &= \begin{cases} r^F + \frac{(1-p)}{p}\left(r^F - r^L\right) & \textit{if} \;\; p^2 > \frac{r^F - r^L}{r^H - r^L} \\ r^F + \frac{(1-p)}{p}x\left(r^F - r^L\right) & \textit{if} \;\; p^2 = \frac{r^F - r^L}{r^H - r^L} \\ r^F & \textit{if} \;\; p^2 < \frac{r^F - r^L}{r^H - r^L} \end{cases}
\end{aligned}
$$

Propositions **??** and **??** highlight the difference between the two equilibria. In the case with Regulator committed to the liquidation of the insolvent bank, the assumption (**??**) suffices to guarantee that the intermediation (bank) links creditors and borrowers. If there is an ambiguity with respect to the bailout of the insolvent bank, and the bank expects it would be bailed out at the expense of the shareholders (through which the bailout costs are internalized by the bank who maximizes the expected profit of its shareholders), the bank exhibits cautionary behavior. This results in riskless investment and the deposit interest rate at the riskless level in case of low enough probability of success for the risky asset ($p < \sqrt{\frac{r^F - r^L}{r^H - r^L}}$). The objective function of the bank is then zero, which induces indifference with respect to the level of deposits with the bank. Remember, it was assumed that in case of equality of the deposit rate to the riskless one, the depositors still prefer deposits to the riskless asset. This explains why the total amount invested in deposits is equal to unit in equilbrium. Still, the total amount invested in the risky asset is zero.

Compare now the monopolistic equilibrium with that in the market economy (Corollary **??**). When the Regulator was committed to the liquidation of insolvent banks, the intermediated economy exhibited the same allocation of resources between risky and riskless asset as the market one. As soon as the costs of possible bailout are internalized by the bank, the equilibrium allocation is different. If the risky asset is understood as productive firms, the link between creditors (depositors) and borrowers (firms) would be broken in case of the intermediated economy. However the crucial role in this failure is played not by the internalization of bailout costs, but rather by the asymmetry in beliefs of depositors and bankers with regards to the bailout rule. In the next chapter, I eliminate this asymmetry in beliefs and show that the intermediation may efficiently link creditors and borrowers if there exist a precise bailout rule.

2.4.3 Competitive Equilibrium

Consider again a banking sector with infinitely many banks distributed at the interval $[0, 1]$. In contrast to Section **??**, competitive banks maximize now their objective function as given by (**??**). This results in the following optimisation problem:

$$\begin{aligned} \Pi^e &= \left[x\left(pr^H + (1-p)\,r^L\right) + (1-x)\,r^F - r^D\right] D \rightarrow \max_{x,D} \\ \text{s.t. } D &\geq 0 \\ 0 &\leq x \leq 1 \end{aligned}$$

Solution of this problem determines again the demand of each bank (and hence the aggregate demand) for deposits $D^d = D^d\left(r^D, x\right)$.

Proposition 2.8 *If the banks internalize the costs of bailout, their competitive demand for* *deposits D^d and the composition of their assets portfolios x^* is given by:*

$$D^d \in \begin{cases} \{0\} & \textit{if } r^D > pr^H + (1-p)\, r^L \\ [0,\infty) & \textit{if } r^D = pr^H + (1-p)\, r^L \\ \{\infty\} & \textit{if } r^D < pr^H + (1-p)\, r^L \end{cases}$$

$$x^* \in \begin{cases} \{0\} & \textit{if } r^D > pr^H + (1-p)\, r^L \\ \{1\} & \textit{if } r^D \leq pr^H + (1-p)\, r^L \end{cases}$$

Under competition, banks also exhibit more cautionary behavior if they internalize the bailout costs. From the comparison of propositions **??** and **??**, it is easy to see that the demand of competitive banks for deposits is limited if they internalize the bailout costs. If the interest rate on deposits is higher than the expected return on the risky asset, the banks opt not to operate, since otherwise the expected profit of shareholders is negative.

To study the effect of the costs internalization on the interest rate, we need to find the conmpetitive equilibrium in accordance with the Definition **??**.

Proposition 2.9 *If the banks expect to be bailed out in the case of insolvency at costs of their shareholders, but the depositors expect insolvent banks to be liquidated, the competitive equilibrium is given by:*

$$\begin{aligned} X^* &= 1 \\ D^* &= \begin{cases} 1 & \textit{if } p^2 \geq \frac{r^F - r^L}{r^H - r^L} \\ 0 & \textit{if } p^2 < \frac{r^F - r^L}{r^H - r^L} \end{cases} \\ r_c^D &\in \begin{cases} pr^H + (1-p)\, r^L & \textit{if } p^2 \geq \frac{r^F - r^L}{r^H - r^L} \\ \left[pr^H + (1-p)\, r^L ; r^F + \frac{(1-p)}{p}\left(r^F - r^L\right)\right] & \textit{if } p^2 < \frac{r^F - r^L}{r^H - r^L} \end{cases} \end{aligned}$$

Graphically, the competitive equilibrium is presented in Figure **??**. If the expected return on the risky asset $pr^H + (1-p)\, r^L$ exceeds or is equal to the rate $r^F + \frac{1-p}{p}\left(r^F - r^L\right)$, which makes expected return on deposits equal to the risk-less rate, the equilibrium amount of deposits with banks equals to unit, and banks invest the total amount of accumulated deposits in the risky assets.

This is only possible if

$$\begin{aligned} pr^H + (1-p)\, r^L &\geq r^F + \frac{1-p}{p}\left(r^F - r^L\right) \\ &\Leftrightarrow \\ p^2 &\geq \frac{r^F - r^L}{r^H + r^L} \end{aligned}$$

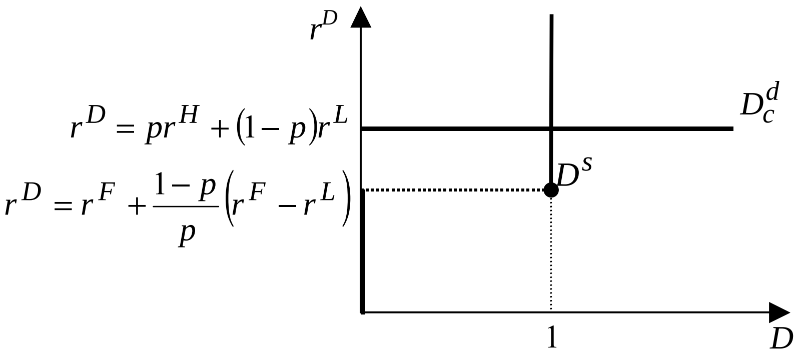

Figure 2.9. Competitive equilibrium if there is no commitment of the regulator with regard to failure resolutions, which produces asymmetry in the beliefs of depositors and bankers.

If this condition is not met, the equilibrium results in disintermediation. As in the case of the monopolist bank, if risky asset is considered to represent productive firms, the intermediated economy would fail to link creditors (depositors) and borrowers (firms), although the market economy would provide for such a link under the same parameters p, r^H, r^L and r^F (see Corrolary **??**).

Corollary 2.3 *If the Regulator does not commit to liquidate insolvent banks, and there is an asymmetry in beliefs between the depositors and the bankers, and if the banks internalize the bailout costs, intermediated economy may fail to provide the same allocation of resources as the market economy.*

2.5 Intermediated Economy: uncertain bailout rule

If the Regulator does not commit to the liquidation of failing financial institutions, the link between creditors and borrowers may be broken. Still, regulatory authorities avoid committing to some precise bailout rule, as this may increase moral hazard in the financial sector. Although moral hazard is not explicitly modelled here, the case of the Regulator committed to the liquidation of failing banks demonstrates that banks tend to set deposit interest rate excessively high. Along with that, the resulting allocation of resources is indeterminate and does not necessarily replicate the one of the market equilibrium. In the following, I consider a bailout rule, which does not presume commitment to liquidation or commitment to a bailout, but rather induces uncertainty about the policy of the Regulator.

As above, the Regulator is responsible for bailouts or liquidation of banks. The bailout presumes subsidizing the bank in order to make it able to pay the deposits out in full. The subsidy is financed through the taxes collected from the bank's shareholders. The liquidation means transferring the value of an insolvent bank to the depositors, which [partially] indemnifies them for the banks' debts. The solvency resolution takes place in the period 2, as above (see Fig.**??**).

In general, the Regulator does not promise to save banks unambiguously, but rather announces some probability of bailouts z. If the banks in period 2 are not able to repay all their debts, the Regulator can intervene and bail the banks out. If the bailout is performed (which probability is z), depositors receive their deposits in full with interest accrued on them. If however the bailout is not performed, the banks are liquidated and the repayment to depositors are determined by the value of banks' assets in period 2. Depositors are informed about the values of p, z and about the share of risky asset in banks' portfolios x, so that they can build expectations about future repayments on deposits, given the announced deposit rate r^D.

Two bailout scenarios are possible. In case of unconditional bailouts the Regulator saves failing financial institutions in period 2 with probability z, whatever is the state of the nature in period 2. In case of conditional bailouts the Regulator saves failing financial institutions with probability z only if "L"-state of nature is realized in period 2. Since in equilibrium banks can fail only if the state of nature "L" is realized, both scenarios lead to the same equilibrium outcome. Therefore, all considerations hereinafter are based at the example of unconditional bailouts.

Lemma 2.2 Given the parameters r^H, r^F, r^L and p and the probability of bailout z, the probability ρ of the event that depositors get their funds back in full is a function of r^D and x:

$$\rho\left(x;r^D\right)=\begin{cases} z & \text{if} \quad r^D>\widetilde{r}^H \\ p+(1-p)\,z & \text{if} \quad \widetilde{r}^H\geq r^D>\widetilde{r}^L \\ 1 & \text{if} \quad r^D\leq\widetilde{r}^L \end{cases} \tag{2.21}$$

Here $\widetilde{r}^H$ and $\widetilde{r}^L$ are defined as in (**??**). Compare now Lemma **??** with Lemma **??**. If the Regulator commits to follow an uncertain bailout rule, the probability of the event that the households get their deposits back in full, is higher (except the case $r^D\leq\widetilde{r}^L$, when the bank

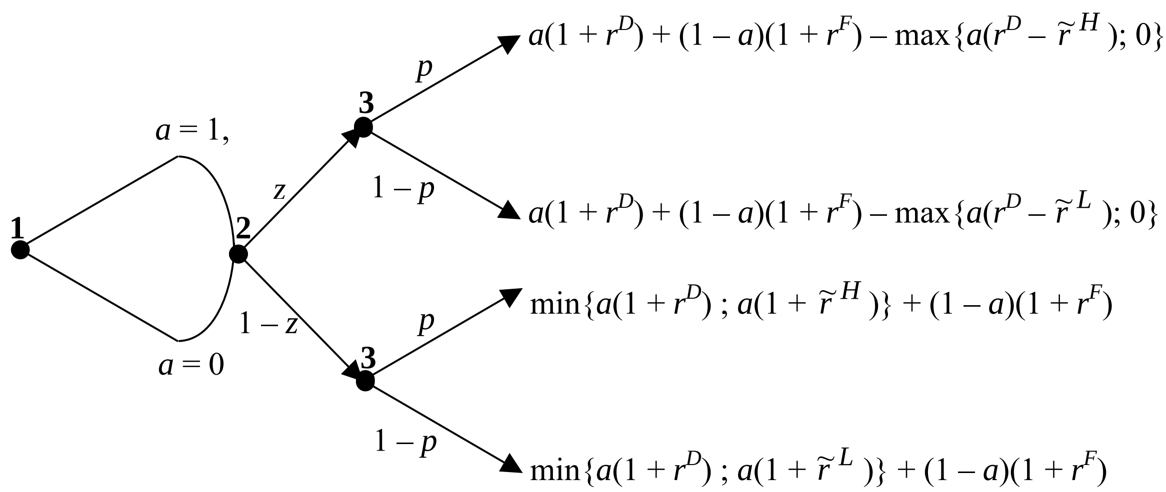

Figure 2.10. Decision-tree of households in case of bailouts with probability z.

can repay on deposits in any state of nature). Hence, it is now possible under a lower deposit rate that the expected return on deposits is equal to the risk-free rate.

Remember still, that a bailout is performed through the collection of taxes from the shareholders of the banks. Since all depositors are shareholders of the banks, they count for such tax collection in their decision-making.

2.5.1 Households

Consider the decision of the households in case the Regulator commits in the period 1 to an uncertain bailout rule: no matter what is the state of the nature in the period 2, banks are bailed out with probability z. As in Section **??**, they maximize their expected profit from the investment of a unit endowment. The decision-tree of the households is presented in Figure **??**

In Figure **??**, the households decide in node 1 upon their portfolio composition a. In node 2, the Regulator decides whether to liquidate the bank or to bail it out. Bailout happens with the probability z, and the liquidation with the probability $1 - z$. In node 3, the state of nature is realized. If the Regulator liquidates insolvent banks (with probability $1 - z$) then the payoffs to the households in each state of nature repeats those in Figure **??**, where only liquidation was possible. If the Regulator decides to bail the failing banks out, it collects taxes from households to subsidize insolvent banks. The amount of the tax $\theta^{\mathbf{s}}$ ($\mathbf{s} \in \{H, L\}$) depends on the state of nature:

$$\begin{aligned}\theta^{\mathbf{s}} &= \max\left\{\left[r^D - \left(xr^{\mathbf{s}} + (1-x)\,r^F\right)\right]a; 0\right\} = \\ &\quad \max\left\{\left(r^D - \widetilde{r}^{\mathbf{s}}\right)a; 0\right\}\end{aligned}$$

The state-contingent payoff $G^{\mathbf{s}}$ to households in case of a bailout is therefore determined by the deposit payoff $a\left(1 + r^D\right)$ and the portfolio payoff $(1-a)\left(1 + r^F\right)$ deduced by the tax $\theta^{\mathbf{s}}$:

$$\begin{aligned}G^{\mathbf{s}} &= a\left(1 + r^D\right) + (1-a)\left(1 + r^F\right) - \max\left\{\left(r^D - \widetilde{r}^{\mathbf{s}}\right)a; 0\right\} = \\ &= \min\left\{\left(1 + r^D\right)a; \left(1 + \widetilde{r}^{\mathbf{s}}\right)a\right\} + (1-a)\left(1 + r^F\right)\end{aligned}$$

which is the same as if insolvent banks were liquidated. The explanation for that is that the banks are bailed out at costs of their shareholders, which are the depositors of the bank. No matter whether the bank is bailed out or not, the payoff of the households is equal either to the announced deposit payoff (with the rate r^D) if the bank is solvent (if $r^D \leq \widetilde{r}^{\mathbf{s}}$), or to the value of the bank's portfolio (which returns with the rate $\widetilde{r}^{\mathbf{s}}$ in state s) if the bank is insolvent (if $r^D \leq \widetilde{r}^{\mathbf{s}}$). Hence, the decision-tree of the households reduces to the one in Figure **??** and Proposition **??** holds. The supply of deposits is given by (**??**):

$$D^s\left(r^D, x\right) = \begin{cases} 1 & \text{if} \quad r^D \geq r^F + \frac{(1-p)}{p}x\left(r^F - r^L\right) \\ 0 & \text{if} \quad r^D < r^F + \frac{(1-p)}{p}x\left(r^F - r^L\right) \end{cases} \tag{2.22}$$

2.5.2 Banks

Similarly to the case of the households, the decision-tree of the bank combines now those of liquidation (Fig. **??**) and bailout (Fig. **??**) cases. In Figure **??**, the bank makes decision with regards to x and D (and r^D in case of monopoly) in node 1. The Regulator decides in node 2 whether to bail the bank out (with probability z) or to liquidate it (with probability $1-z$). In node 3, the state of nature is realized. If the bank is bailed out, it internalizes the costs of the bailout as in the case of ambiguous bailouts above (Section **??**). If the bank is

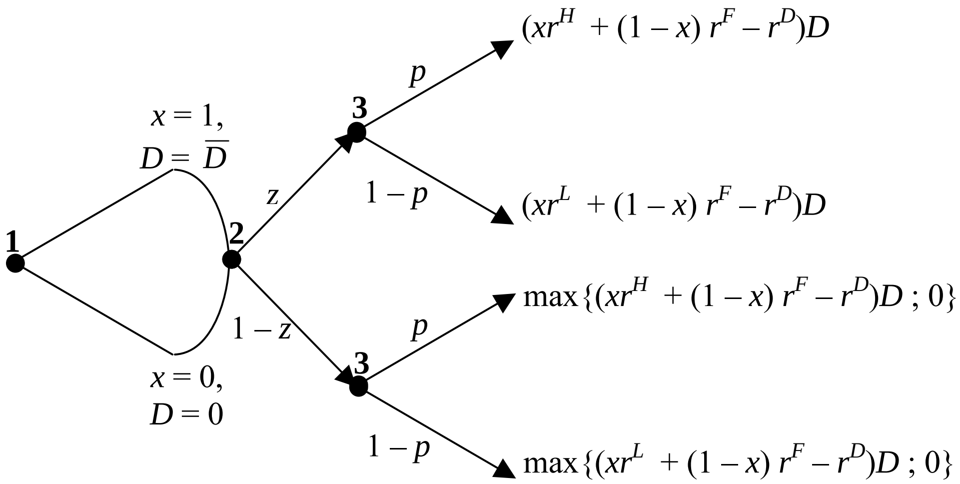

Figure 2.11. Decision-tree of banks in case of bailouts with probability z.

liquidated, its payoffs repeat those from the liquidation case.

The objective function of the bank accounts now for the possibility of bailouts:

$$\begin{aligned}\Pi^e &= z\left[x\left(pr^H+(1-p)\,r^L\right)+(1-x)\,r^F-r^D\right]D+ \\ &\quad (1-z)\,p\max\left[xr^H+(1-x)\,r^F-r^D;0\right]D+ \\ &\quad (1-z)\,(1-p)\max\left[\left(xr^L+(1-x)\,r^F-r^D\right);0\right]D\end{aligned} \tag{2.23}$$

2.5.3 Monopolistic Equilibrium

Again, the monopolist bank maximizes its objective function

$$\begin{aligned}\Pi^e &\rightarrow \max_{x,D,r^D} \\ \text{s.t.} \quad & 0\le x\le 1 \\ & 0\le D\le D^s\left(r^D,x\right)\end{aligned}$$

where $D^s\left(r^D,x\right)$ is given by (**??**). Since the deposit supply function is the same as in the case of the Regulator committed to the liquidation, one can expect that the monopolist bank would choose the same deposit interest rate as in Proposition **??**, if it guarantees that the objective function of the bank (**??**) is positive.

Proposition 2.10 *If the Regulator bails the bank out at costs of its shareholders with probability z, the optimal choice $\left(x^{*},D^{*},r_{m}^{D}\right)$ of the monopolistic bank is*

$$x^{*}\in\begin{cases}\{1\} & \textit{if } \frac{p^{2}}{z+(1-z)p}>\frac{r^{F}-r^{L}}{r^{H}-r^{L}}\\ [0,1] & \textit{if } \frac{p^{2}}{z+(1-z)p}=\frac{r^{F}-r^{L}}{r^{H}-r^{L}}\\ \{0\} & \textit{if } \frac{p^{2}}{z+(1-z)p}<\frac{r^{F}-r^{L}}{r^{H}-r^{L}}\end{cases}$$

$$D^{*}\in\begin{cases}\{1\} & \textit{if } \frac{p^{2}}{z+(1-z)p}>\frac{r^{F}-r^{L}}{r^{H}-r^{L}}\\ [0,1] & \textit{if } \frac{p^{2}}{z+(1-z)p}\leq\frac{r^{F}-r^{L}}{r^{H}-r^{L}}\end{cases}$$

$$r_{m}^{D}=\begin{cases}r^{F}+\frac{(1-p)}{p}\left(r^{F}-r^{L}\right) & \textit{if } \frac{p^{2}}{z+(1-z)p}>\frac{r^{F}-r^{L}}{r^{H}-r^{L}}\\ r^{F}+\frac{(1-p)}{p}x\left(r^{F}-r^{L}\right) & \textit{if } \frac{p^{2}}{z+(1-z)p}=\frac{r^{F}-r^{L}}{r^{H}-r^{L}}\\ r^{F} & \textit{if } \frac{p^{2}}{z+(1-z)p}<\frac{r^{F}-r^{L}}{r^{H}-r^{L}}\end{cases}$$

Note that the expression $z+(1-z)\,p\equiv p+(1-p)\,z$ is exactly the probability ρ of the event that deposits are repaid in full. The condition $\frac{p^{2}}{z+(1-z)p}>\frac{r^{F}-r^{L}}{r^{H}-r^{L}}$turns to $p^{2}>\frac{r^{F}-r^{L}}{r^{H}-r^{L}}$ as soon as the probability of bailout is $z=1$, in which case the optimal choice of the monopolistic bank would coincide with the one in case of ambiguous bailouts, when the bank expects the bailout to take place. Although households are now informed about the probability of bailouts, and there is no asymmetry in beliefs, the expected payoff to the households is the same as in case of the liquidation of the bank, since the bank is bailed out at costs of the households. If bailout is performed with the probability $z=0$, we obtain the case of the commitment of the Regulator to liquidation of the insolvent banks.

To find the equilibrium, we need to set the deposit supply equal to the deposit demand. Since the bank is indifferent with respect to the amount of deposits collected if $\frac{p^{2}}{z+(1-z)p}\leq\frac{r^{F}-r^{L}}{r^{H}-r^{L}}$, but still sets the deposit interest rate so that the expected return on deposits is equal to the risk-free return, the equilibrium amount of deposits with the bank is equal to unity, as given by the deposit supply.

Proposition 2.11 *If the Regulator bails the bank out at costs of its shareholders with prob-*

ability z, the monopolistic equilibrium is given by the following:

$$\begin{aligned}
X^* &\in \begin{cases} \{1\} & \textit{if } \frac{p^2}{z+(1-z)p} > \frac{r^F-r^L}{r^H-r^L} \\ [0,1] & \textit{if } \frac{p^2}{z+(1-z)p} = \frac{r^F-r^L}{r^H-r^L} \\ \{0\} & \textit{if } \frac{p^2}{z+(1-z)p} < \frac{r^F-r^L}{r^H-r^L} \end{cases} \\
D^* &= 1 \\
r_m^D &= \begin{cases} r^F + \frac{(1-p)}{p}\left(r^F - r^L\right) & \textit{if } \frac{p^2}{z+(1-z)p} > \frac{r^F-r^L}{r^H-r^L} \\ r^F + \frac{(1-p)}{p}\left(r^F - r^L\right) \cdot X^* & \textit{if } \frac{p^2}{z+(1-z)p} = \frac{r^F-r^L}{r^H-r^L} \\ r^F & \textit{if } \frac{p^2}{z+(1-z)p} < \frac{r^F-r^L}{r^H-r^L} \end{cases}
\end{aligned}$$

The effect of the bailouts on the equilibrium allocation is easy to see if one compares the propositions **??** and **??**. Since the monopolist bank always sets the deposit interest rate at such a level that the expected payoff to the depositors is equal to the risk-free interest rate, the amount of deposits in the system is equal to unity. Households do not invest in the risk-free asset.

With $z = 0$ the monopolistic equilibrium repeats the one of the case with the Regulator committed to the liquidation of the insolvent bank. With $z = 1$ we obtain the same equilibrium allocation as in the case of ambigous bailouts, with the bank expecting a bailout and the households expecting the liquidation of the insolvent bank. Although the asymmetry in beliefs of both households and bankers is now eliminated from the model, the equilibrium allocation is exactly the same as in the case of asymmetric beliefs. The reason for that is that depositors can not distinguish between bailouts and liquidation due to the specific bailout rule considered in this chapter: the bank is subsidized at the expense of the depositors.

Finally, it is easy to see that introducing bailouts shrinks the interval of p, where the inefficiency of intermediation may appear. Indeed, now the allocation X^* of funds into the risky asset is identical to the one of the market economy (i.e. is equal to unity) as soon as $\frac{p^2}{z+(1-z)p} > \frac{r^F-r^L}{r^H-r^L}$. This means that for any p, r^H, r^L, and r^F, the probability of bailout z may be choosen at the level $z < \frac{p}{1-p}\frac{pr^H+(1-p)r^L-r^F}{r^F-r^L}$ to ensure the efficiency of the intermediation. The right-hand side of this inequality is always positive due to the assumptions **??** and **??**. Note, that it does not require from the Regulator to commit to the liquidation ($z = 0$) in order to ensure the efficiency of the intermediation. As before, the efficiency is understood as the ability of the intermediated system to replicate the allocation achieved in the market equilibrium.

2.5.4 Competitive Equilibrium

Under the competition, the banks again maximize their objective function (**??**)

$$\begin{aligned} \Pi^e &\rightarrow \max_{x,D} \\ \text{s.t.} \quad & 0 \leq x \leq 1 \\ & 0 \leq D \end{aligned}$$

Again, the principal difference from the monopolistic case is that the banks cannot decide upon the interest rate r^D, and only choose the optimal portfolio x and the amount of deposits D, which would be optimal for them under the deposit rate r^D, which is determined by the market. As a result, we obtain the demand of the competitive banks for deposits $D^d\left(r^D, x\right)$.

Proposition 2.12 *If the Regulator bails the banks out at costs of their shareholders with probability $z \in (0,1]$, the optimal choice (x^*, D^*) of each competitive bank is:*

$$D^d \in \begin{cases} \{0\} & \text{if } r^D > \frac{1}{p+z(1-p)}\left(pr^H + z\left(1-p\right)r^L\right) \\ [0,\infty) & \text{if } r^D = \frac{1}{p+z(1-p)}\left(pr^H + z\left(1-p\right)r^L\right) \\ \{\infty\} & \text{if } r^D < \frac{1}{p+z(1-p)}\left(pr^H + z\left(1-p\right)r^L\right) \end{cases}$$

$$x^* \in \begin{cases} [0;1] & \text{if } r^D > \frac{1}{p+z(1-p)}\left(pr^H + z\left(1-p\right)r^L\right) \\ \{1\} & \text{if } r^D \leq \frac{1}{p+z(1-p)}\left(pr^H + z\left(1-p\right)r^L\right) \end{cases}$$

Note that if the bailouts are performed with the probability $z = 1$, the choice of the competitive banks repeats the one described in Proposition **??**. If the Regulator commits to the liquidation of insolvent banks ($z = 0$), Proposition **??** is valid instead of Proposition **??**. The reason for that is that setting $z = 0$ eliminates any internalization of the bailout costs by the banks, and hence their choice with regards to the amount of deposits is not anymore zero under $r^D > r^H$ but rather it is indeterminate $D^d \in [0,\infty)$. Commitment to liquidation creates limited liability of the banks, and their objective function under $r^D > r^H$ is always zero, which implies indifference with regards to the amount of deposits.

To determine the competitive equilibrium we again need to check the condition $D^d = D^s$.

Proposition 2.13 *If the Regulator bails the banks out at costs of their shareholders with* *probability $z \in (0,1]$, the competitive equilibrium is given by the following:*

$$X^* = \begin{cases} 1 & \textit{if} \;\; \frac{p^2}{p+z(1-p)} \geq \frac{r^F-r^L}{r^H-r^L} \\ 0 & \textit{if} \;\; \frac{p^2}{p+z(1-p)} < \frac{r^F-r^L}{r^H-r^L} \end{cases}$$

$$D^* = \begin{cases} 1 & \textit{if} \;\; \frac{p^2}{p+z(1-p)} \geq \frac{r^F-r^L}{r^H-r^L} \\ 0 & \textit{if} \;\; \frac{p^2}{p+z(1-p)} < \frac{r^F-r^L}{r^H-r^L} \end{cases}$$

$$r_c^D = \frac{1}{p+z(1-p)} \left(pr^H + z(1-p)\, r^L\right)$$

Note again that under $z \to 0$, this equilibrium is very similar to the competitive equilibrium in case of commitment of the Regulator to the liquidation of insolvent banks. If $z = 0$, Proposition **??** is valid instead of Proposition **??**, since the case of $z = 0$ eliminates the internalization of bailout costs by banks and introduces limited liability.

If $z = 1$, we obtain Proposition **??** since the banks behave exactly as in the case where they believe to be bailed out at costs of their shareholders.

Proposition **??** highlights the same effect of the bailout as in the case of a monopolist bank: the interval of values of p, where an inefficiency of the intermediation was possible under umbiguous bailouts, now shrinks. Moreover, again there exists a possibility for the Regulator to set the probability of the bailout z at the level below $\frac{p}{1-p}\frac{pr^H+(1-p)r^L-r^F}{r^F-r^L}$ in order to ensure the efficient intermediation.

Corollary 2.4 *If the Regulator commits to bail the banks out with an announced probability z, and the bailouts are performed through subsidizing banks with help of taxes collected from households, there is a possibility for the Regulator to eliminate the inefficiency of the intermediation compared to the case of ambigous bailouts. Due to the internalization of bailout costs by banks, the interest rate in competitive banking sector is lower than under commitment of the Regulator to liquidation.*

2.6 Summary

The literature on financial intermediation stresses the role of financial intermediaries in channelling funds from creditors to borrowers if both parties can not directly deal in the financial market. I alter this setting and study the decision of households, who choose between two investment projects: one risky and one risk-free. A risky investment project could represent productive firms, but I call it for simplicity a risky asset and assume the supply of it to be absolutely elastical. The starting point in this chapter was the analysis of the market economy, which demonstrated that if the expected return on the risky asset is above the risk-free rate, the risk-neutral creditors (households) would invest their whole endowment in the risky asset. The analysis shows however that the intermediation can fail to do this depending on the bailout policy of the Regulator.

I consider three types of the bailout policy, which differ in the commitment of the Regulator to a certain bailout rule, and two types of banking system: monopolistic one and competitive one. If the Regulator commits to liquidate insolvent banks, the banking system provides a missing link between creditors and borrowers in case the banking sector has a monopolistic structure. The model demonstrates that the same amount of funds is invested in the risky asset, as in the case of the market economy. Still, households face a lower expected return than in the case of the market economy, since the monopolist bank sets the deposit rate at the lowest possible level. Though in my model all depositors are shareholders of the bank and obtain the bank's profit as dividend, which provides them with the same expected return as in the market economy, a distortion of the expected return could be possible if only a part of depositors act as shareholders.

In the case of a competitive banking system, households still deposit with banks, but whether the banks invest in risky projects, and to what extent, is indeterminate: $x^* \in [0;1]$. Moreover, the competitive equilibrium in the commitment case produces arbitrarily high deposit interest rates. This is why the probability of the deposits being repaid in full is zero. Depositors know this and count only on the expected liquidation value of the banks, which is still higher than the return from the safe asset.

In the world with ambigous bailout policy (the Regulator does not commit to liquidate insolvent banks) an asymmetry in beliefs between depositors and bankers with regards to the insolvency resolution can arise. I consider the case with depositors expecting an insolvent bank to be liquidated, but banks expecting to be bailed out at the expense of their shareholders. If banks are actually bailed out at shareholders' costs, they internalize the costs of bailout. As a result, this leads to a lower equilibrium deposit rate in a competitive banking sector. However, the asymmetry in views of depositors and banks with regards to the insolvency resolution generates another possibility for financial intermediation to fail in chan-

Regulator's Policy	**Depositors' beliefs**	**Bankers' beliefs**	**Internalization of costs**
Commitment	Liquidation	Liquidation	by depositors
Ambiguity	Liquidation	Subsidy	by banks and depositors
Uncertainty	Subsidy with probability z	Subsidy with probability z	by banks and depositors
Forbearance	Continuation with probability z	Continuation with probability z	by banks

Table 2.1. Types of the bailout policy

nelling funds from depositors to the risky asset market. This failure arises if the probability of success for the risky investment is not sufficiently high.

Finally, I suggest that a Regulator can commit to a bailout rule, which presumes bailouts with probability z. This allows to make the banks internalize the costs of bailouts, and at the same time allows the Regulator to reestablish the efficiency of the intermediation through controlling the probability of bailouts.

The variety of the bailout policies, which are considered in the current chapter and in the next one, is summarized in Table **??**. The table shows the beliefs of depositors and bankers regarding the insolvency resolution, and the internalization of the bailout/liquidation costs by the parties. If the Regulator commits to the liquidation of insolvent banks, both depositors and bankers believe an insolvent bank will be liquidated. In this case depositors internalize the liquidation costs since they obtain only the liquidation value of the bank. If the Regulator follows ambiguity in the bailout policy, the asymmetry in beliefs arises: depositors believe an insolvent bank will be closed, and bankers believe an insolvent bank will be bailed out through a subsidy. Again, depositors internalize liquidation costs, as in case of liquidation; at the same time, the bank internalizes bailout costs, since the bank maximizes the profit of its shareholders, which a charged with taxes to subsidize the insolvent bank. If the Regulator follows a stochastic (uncertain) bailout rule, there is an uncertainty with regards to the liquidation of an insolvent bank, but both depositors and bankers have symmetric information (and symmetric beliefs) about the probability z, with which an insolvent bank will be bailed out through a subsidy. In this case both banks and depositors internalize the costs, as above.

Studying the effects of the regulatory forbearance is not possible in the static framework of the current chapter. I proceed in the next chapter with a dynamic version of the model to study the case of forbearance, which assumes that an insolvent bank may avoid liquidation and continue its operations with probability z. In this case, the bank internalizes the costs of bailout, since the bailout is effectively performed by the next generation of depositors. On the contrary, current depositors do not internalize the costs of bailouts, as shown in Table **??**.

The organization of bailouts was an important issue of the model in the current chapter. It was assumed that in order to subsidize failing banks in the case of a bailout, the Regulator collects taxes from the population, all members of which are both depositors and shareholders of the bank. The issue of the internalization of bailout costs is of crucial importance for the results. It could be possible to alter the proportion of shareholders in the population to obtain the result in which the population does not completely internalize the costs of the bailouts, but the banks do. The next chapter deals with the case of no internalization of bailout costs by depositors.

Appendix 2.A

Proofs

Proof of Lemma **??**.

Proof.

In line with the notation in the text of the chapter, $xr^H + (1-x)r^F = \widetilde{r}^H$ and $xr^L + (1-x)r^F = \widetilde{r}^L$ Consider three following possibilities:

(1) $r^D > \widetilde{r}^H$. In this case

$$V^{\mathrm{s}} \leq V^H = \left[x\left(1+r^H\right) + (1-x)\left(1+r^F\right)\right] D < \left(1+r^D\right) D$$

with probability 1, and the bank is solvent with probability $\rho = 0$.

(2) $\widetilde{r}^H \geq r^D > \widetilde{r}^L$. In the state of nature "H" (with probability p)

$$V^H = \left[x\left(1+r^H\right) + (1-x)\left(1+r^F\right)\right] D \geq \left(1+r^D\right) D$$

and the bank is solvent. In the state of nature "L" (with probability $1-p$)

$$V^L = \left[x\left(1+r^L\right) + (1-x)\left(1+r^F\right)\right] D < \left(1+r^D\right) D$$

and the bank is insolvent, so that the probability, with which depositors obtain their repayment in full, is $\rho = p$

(3) $r^D \leq \widetilde{r}^L$. The bank is always able to repay its obligations,

$$V^{\mathrm{s}} \geq V^L = \left[x\left(1+r^L\right) + (1-x)\left(1+r^F\right)\right] D \geq \left(1+r^D\right) D$$

with probability $\rho = 1$.

■

Proof of Proposition **??**

Proof.

First, recall that aggregate deposit supply is given by (**??**): $D^s = a$. To derive the equation (**??**), substitute here for the optimal choice of a by households. To do it, consider the same three cases as in Lemma **??**.

The solution a of the problem (**??**) can be found as follows:

(1) $r^D > \widetilde{r}^H \Rightarrow a = 1$ since $x\left(pr^H + (1-p)\,r^L\right) + (1-x)\,r^F > r^F$ due to the Assumption **(??)**

(2) $\widetilde{r}^H \geq r^D > \widetilde{r}^L \Rightarrow$

$$a \in \begin{cases} \{1\} & \text{if} \quad pr^D + (1-p)\left(xr^L + (1-x)\,r^F\right) > r^F \\ [0,1] & \text{if} \quad pr^D + (1-p)\left(xr^L + (1-x)\,r^F\right) = r^F \\ \{0\} & \text{if} \quad pr^D + (1-p)\left(xr^L + (1-x)\,r^F\right) < r^F \end{cases} \tag{2.A.1}$$

(3) $r^D \leq \widetilde{r}^L \Rightarrow a = 0$ since $r^D < r^F$

The proof reduces therefore to consideration of the case $xr^H + (1-x)r^F \geq r^D > xr^L + (1-x)r^F$.

Condition $pr^D + (1-p)\left(xr^L + (1-x)r^F\right) > r^F$ is automatically met if $r^D > xr^H + (1-x)r^F$ and can be extended for the case $r^D > \widetilde{r}^H$:

$$\begin{aligned} pr^D + (1-p)\left(xr^L + (1-x)r^F\right) &> \\ p\left(xr^H + (1-x)r^F\right) + (1-p)\left(xr^L + (1-x)r^F\right) &= \\ x\left(pr^H + (1-p)\,r^L - r^F\right) + r^F &> r^F \end{aligned}$$

Condition $pr^D + (1-p)\left(xr^L + (1-x)\,r^F\right) < r^F$ is automatically met if $r^D < xr^L + (1-x)r^F$ and can be extended for the case $r^D \leq \widetilde{r}^L$:

$$\begin{aligned} pr^D + (1-p)\left(xr^L + (1-x)r^F\right) &< \\ p\left(xr^L + (1-x)r^F\right) + (1-p)\left(xr^L + (1-x)r^F\right) &= \\ x\left(r^L - r^F\right) + r^F &< r^F \end{aligned}$$

Finally, condition $pr^D + (1-p)\left(xr^L + (1-x)r^F\right) \gtreqless r^F$ is equivalent to:

$$r^D \gtreqless r^F + \frac{(1-p)}{p}x\left(r^F - r^L\right)$$

if $p > 0$.

■

Proof of Proposition **??**

Proof.

Consider three following cases:

(1) $r^D \geq \widetilde{r}^H \Rightarrow$ the expected profit of the bank is zero, and the bank is indifferent with

respect to the choice of x and D: $x \in [0;1]$ and $D \in [0;D^s]$. The latter leads to

$$D \in \begin{cases} [0;1] & \text{if } r^D \geq r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right) \\ \{0\} & \text{if } r^D < r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right) \end{cases}$$

Since $r^D \geq \widetilde{r}^H$, the solution $D \in [0;1]$ is only possible if either

$$r^D \geq r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right) \geq x r^H + (1-x) r^F \tag{2.A.2}$$

or

$$r^D \geq x r^H + (1-x) r^F \geq r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right) \tag{2.A.3}$$

For the inequality (**??**) we have

$$\begin{aligned} r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right) &\geq x r^H + (1-x) r^F \Leftrightarrow \\ \frac{(1-p)}{p} x \left(r^F - r^L\right) &\geq x r^H - x r^F \end{aligned} \tag{2.A.4}$$

Now, if $x = 0$, the inequality (**??**) is always met. Otherwise it implies

$$(1-p)\left(r^F - r^L\right) \geq p r^H - p r^F$$

which contradicts the Assumption **??**.

The inequality (**??**) is always true due to the Assumption **??**.

Similarly, the solution $D = 0$ is only possible if the inequality (**??**) is met, which is only possible if $x = 0$ (see above).

(2) $\widetilde{r}^H > r^D \geq \widetilde{r}^L \Rightarrow$ the expected profit of the bank is given by

$$\Pi^e = p\left(\widetilde{r}^H - r^D\right) D \geq 0 \tag{2.A.5}$$

Note that $D = 0$ is not optimal for the bank since $\widetilde{r}^H > r^D$. Hence, it is not optimal for the bank to set $r^D < r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$. Hence if $D > 0$, the optimal choice of the bank is $x = 1$ due to $r^H > r^F$which leads to the optimal choice of $D = 1$ under $r^D \geq r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$. The expected profit depends negatively on r^D, which implies the optimal choice of $r^D_m = r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$. The expected profit depends positively on x (since $r^H > r^F$), which implies $x^* = 1$.

(3) $r^D < \widetilde{r}^L$ implies necessarily $r^D < r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$ since

$$x r^L + (1-x) r^F \leq r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$$

due to

$$xr^L - xr^F \leq \frac{(1-p)}{p} x \left(r^F - r^L\right)$$

which turns to an equality only if $x = 0$; otherwise it turns to

$$pr^L - pr^F < (1-p) \left(r^F - r^L\right)$$

since $r^F > r^L$. Since it is not optimal for the bank to set $r^D < r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$, which would imply $D = 0$, the case $r^D < \widetilde{r}^L$ is irrelevant for the optimal choice of the bank.

Now compare the cases 1 and 2. If the bank sets $r^D \geq \widetilde{r}^H$, its local optima at this interval are $\left\{x^* = 0; D^* \in [0;1]\,; r_m^D \geq r^F\right\}$ and $\left\{x^* \in [0;1]\,; D^* \in [0;1]\,; r_m^D \geq xr^H + (1-x)\, r^F\right\}$. Both are not globally optimal, since in both cases, the expected profit of the bank is zero, and at the same time, there exists an opportunity of setting $x^* = 1$ and $r_m^D = r^F + \frac{1-p}{p} \left(r^F - r^L\right)$ to obtain positive profit.

Summarizing, we obtain the optimal choice of the bank

$$\left\{ \begin{array}{c} x^* = 1 \\ D^* = 1 \\ r_m^D = r^F + \frac{1-p}{p} \left(r^F - r^L\right) \end{array} \right\}$$

Note that $r_m^D < r^H$ due to Assumption **??**.

■

Proof of Proposition **??**

Proof.

One only needs to check whether the definition of equilibrium **??** is met. The optimization problem of the monopolistic bank implies that deposit demand and deposit supply are equal to each other. The solution of the optimzation problem of the monopolistic bank yields the equilibrium values of D_m^*, r_m^D, and x^*, with the latter determining the total amount invested into the risky asset X^*.

The uniqueness follows from the construction.

■

Proof of Proposition **??**

Proof.

The proof is similar to the proof of Proposition **??** above. The main difference in the maximization problem is that the constraint $D \in [0; D^s]$ is relaxed. The banks have infinitely high demand for deposits if the expected profit is positive, which is achieved if $r^D < r^F$, which also implies $x = 1$ to be optimal. If $r^D \geq r^F$, the expected profit of banks is zero due to their limited liability (banks are liquidated in case of insolvency). Under zero expected profit, banks are indifferent with respect to the amount of deposits and to the choice of x. This explains the result.

■

Proof of Proposition **??**

Proof.

Condition $a^* \in \arg\max G^e$ in the definition of equilibrium above is fulfilled through the optimization problem of households. Condition $\left(x^*, D_c^d\right) \in \arg\max \Pi^e$ is met by the choice of the banks. We need now to meet the market clearing condition $D^d\left(r_c^D\right) = D^s\left(r_c^D, x^*\right)$.

Comparing (**??**) and (**??**) we obtain

if $r^D < r^H$, an equilibrium is impossible since deposit demand is infinitely high and deposit supply bounded from above: $D^s \leq 1$.

if $r^D \geq r^H$ then automatically[26] $r^D \geq r^F + \frac{(1-p)x}{p}\left(r^F - r^L\right)$, and deposit supply is $D^s = 1$ while deposit demand is arbitrary, which means that the banks collect exactly the amount of deposits supplied by depositors, and equilibrium amount of deposits is $D^* = 1$. Along with that, the equilibrium interest rate is indeterminate: $r^D \geq r^H$. Since the expected profit of the banks is zero for any x, the choice of x^* is also indeterminate, which implies $X^* \in [0, 1]$ in the equilibrium.

■

Proof of Proposition **??**

Proof.

The Proof repeats the Proof of Proposition **??** with the objective function of the bank as given by (**??**).

[26] Assume $r^F + \frac{(1-p)x}{p}\left(r^F - r^L\right) \geq r^H$. Then $(1-p)x\left(r^F - r^L\right) \geq p\left(r^H - r^F\right)$. But $(1-p)x\left(r^F - r^L\right) \leq (1-p)\left(r^H - r^F\right)$, hence we obtain $(1-p)\left(r^H - r^F\right) \geq p\left(r^H - r^F\right)$, which is a contradiction to (**??**).

■

Proof of Proposition **??**

Proof.

As in Proposition **??**, the equilibrium is ensured by the optimzation programm of the bank. The only difference to the optimal choice of the bank is the case $p^2 \leq \frac{r^F - r^L}{r^H - r^L}$, in which the bank is indifferent with regards to the choice of D, but the supply of deposits is exactly unity, due to the Assumption (**??**). This is due to the fact that the optimization porblem of the monopolistic bank implies the deposit interest rate provide the expected rate of return at the risk-free level. Therefore the amount of deposits in the equilibrium is always equal to unity, independent on the ratio between p^2 and $\frac{r^F - r^L}{r^H - r^L}$.

■

Proof of Proposition **??**

Proof.

Note that since $pr^H + (1-p)\, r^D > r^F$ by assumption (**??**), solution of the maximization problem of a competitive bank is $x^* = 1$ and the proof is straightforward due to linearity of the objective function in the maximisation problem.

■

Proof of Proposition **??**

Proof.

Similarly to the commitment case we need only to meet the market clearing condition $D^d = D^s$. Note that due to $x^* = 1$, the deposit supply function (**??**) turns to

$$D^s = \begin{cases} 1 & \text{if} \quad r^D \geq r^F + \frac{(1-p)}{p}\left(r^F - r^L\right) \\ 0 & \text{if} \quad r^D < r^F + \frac{(1-p)}{p}\left(r^F - r^L\right) \end{cases} \tag{2.A.6}$$

To find the equilibrium we have to distinguish between the following cases:

(1) If $pr^H + (1-p)\, r^L \geq r^F + \frac{(1-p)}{p}\left(r^F - r^L\right)$ then the equality $D^d\left(r^D\right) = D^s\left(r^D\right)$ is fulfilled under competitive interest rate $r_c^D = pr^H + (1-p)\, r^L$, and the equilibrium amount of deposits in banks is $D^* = 1$. Setting interest rate below or above this level

eliminates equilibrium due to $D^d = 0$ or $D^d \to \infty$.

(2) If $pr^H + (1-p)\, r^L < r^F + \frac{(1-p)}{p}\left(r^F - r^L\right)$ then on the one hand $r^D < pr^H + (1-p)\, r^L$ leads to a disequilibrium $D^d \neq D^s$; on the other hand $r^D \geq r^F + \frac{(1-p)}{p}\left(r^F - r^L\right)$ leads as well to a disequilibrium $D^d \neq D^s$. Hence the equilibrium can arise only with $pr^H + (1-p)\, r^L \leq r^D < r^F + \frac{(1-p)}{p}\left(r^F - r^L\right)$, which provides $D^s = 0 = D^d = D^*$.

■

Proof of Lemma **??**

Proof.

The proof is similar to the Proof of Lemma **??**.

■

Proof of Proposition **??**

Proof.

The objective function of the bank is

$$\begin{aligned} \Pi^e &= z\left[x\left(pr^H + (1-p)\, r^L\right) + (1-x)\, r^F - r^D\right] D + \\ &\quad (1-z)\, p \max\left[xr^H + (1-x)\, r^F - r^D; 0\right] D + \\ &\quad (1-z)(1-p) \max\left[\left(xr^L + (1-x)\, r^F - r^D\right); 0\right] D \end{aligned} \tag{2.A.7}$$

Consider the following cases:

1. $\widetilde{r}^H < r^D$. The objective function is negative unless $z = 0$. If $z = 0$, we obtain commitment case, and the bank is indifferent with regards to the amount of deposits and to the allocation of resources x.

2. $\widetilde{r}^L < r^D < \widetilde{r}^H$. The objective function takes the form

$$\begin{aligned} \Pi^e &= z\left[x\left(pr^H + (1-p)\, r^L\right) + (1-x)\, r^F - r^D\right] D + \\ &\quad (1-z)\, p \left(xr^H + (1-x)\, r^F - r^D\right) D \end{aligned} \tag{2.A.8}$$

The first derivative of it with respect to x is

$$\frac{\partial \Pi^e}{\partial x} = \left[pr^H + z(1-p)\, r^L - (z + (1-z)\, p)\, r^F\right] D$$

It is positive if $D > 0$ and the expression in square brackets is positive. Check the latter:

$$\begin{aligned} pr^H + z(1-p)r^L &= pr^H + (1-p)r^L - (1-z)(1-p)r^L > \\ & r^F - (1-z)(1-p)r^L \end{aligned}$$

due to the Assumption (**??**). Now use the Assumption (**??**), which guarantees that $r^F > r^L$, and hence

$$r^F - (1-z)(1-p)r^L \geq r^F - (1-z)(1-p)r^F = (z + (1-z)p)r^F$$

Therefore, the bank sets $x = 1$, if it can obtain positive amount of deposits. To obtain the maximal amount of deposits $D = 1$, it suffices for the bank to set the deposit interest rate at the level $r^D = r^F + \frac{(1-p)}{p}\left(r^F - r^L\right)$, which obviously belongs to the case under consideration, for it satisfies the condition $\widetilde{r}^L < r^D < \widetilde{r}^H$, since $r^L < r^F + \frac{(1-p)}{p}\left(r^F - r^L\right)$ (subtract r^F from both sides to obtain a negative term on the left-hand side and a positive term on the right-hand side) and $r^F + \frac{(1-p)}{p}\left(r^F - r^L\right) < r^H$ (multiply both sides with p to obtain the Assumption **??**).

We only need to prove if the objective function of the bank is positive under this choice:

$$\begin{aligned} z\left[pr^H + (1-p)r^L - r^D\right] + (1-z)p\left(r^H - r^D\right) &= \\ pr^H + z(1-p)r^L - (z + (1-z)p)\left(r^F + \frac{(1-p)}{p}\left(r^F - r^L\right)\right) &> 0 \end{aligned}$$

$\Longleftrightarrow$

$$p^2 r^H + zp(1-p)r^L - (z + (1-z)p)\left(r^F - (1-p)r^L\right) > 0$$

$\Longleftrightarrow$

$$p^2 r^H + pr^L(z(1-p) - z - (1-z)p) > (z + (1-z)p)\left(r^F - r^L\right)$$

$\Longleftrightarrow$

$$p^2\left(r^H - r^L\right) > (z + (1-z)p)\left(r^F - r^L\right)$$

$\Longleftrightarrow$

$$\frac{p^2}{z + (1-z)p} > \frac{r^F - r^L}{r^H - r^L} \tag{2.A.9}$$

Note that if $z = 1$, the last condition reduces to $p^2 > \frac{r^F - r^L}{r^H - r^L}$. If the condition (**??**) turns to be an equality, the objective function of the bank is zero, and the bank is indifferent with regards to the choice of x and D. If the condition (**??**) turns to be an inequality with an opposite sign, the objective function of the bank is negative, and its optimal choice is $x^* = 0$,

$r_m^D = r^F$, and the bank is indifferent with regards to the amount of deposits.

3. $r^D < \widetilde{r}^L$. This implies $D = D^s = 0$, since $\widetilde{r}^L = xr^L + (1-x)\, r^F < r^F + \frac{(1-p)}{p}\left(r^F - r^L\right)$ for any x (the left-hand side is always smaller than r^F, and the right-hand side is always greater than r^F). The objective function is zero, and the bank is indifferent with regards to the choice of x.

■

Proof of Proposition **??**

Proof.

Condition $D^d = D^s$ is met through profit maximisation problem of the bank. It is easy to check, that other conditions from the definition of equilibrium are met as well.

■

Proof of Proposition **??**

Proof.

Each competitive bank maximizes its objective function

$$\begin{aligned} \Pi^e &= z\left[x\left(pr^H + (1-p)\, r^L\right) + (1-x)\, r^F - r^D\right] D + \\ &\quad (1-z)\, p \max\left[xr^H + (1-x)\, r^F - r^D; 0\right] D + \\ &\quad (1-z)\,(1-p) \max\left[\left(xr^L + (1-x)\, r^F - r^D\right); 0\right] D \end{aligned} \tag{2.A.10}$$

The case $xr^H + (1-x)\, r^F < r^D$ is trivial, since leads to $\frac{\partial \Pi^e}{\partial D} < 0$ and consequently to $D^d = 0$. The case $xr^L + (1-x)\, r^F \geq r^D$ is also trivial and leads to the infinitely high deposit demand since $\frac{\partial \Pi^e}{\partial D} > 0$. In the case $xr^H + (1-x)\, r^F \geq r^D > xr^L + (1-x)\, r^F$ the objective function reduces to

$$\begin{aligned} \Pi^e &= z\left[x\left(pr^H + (1-p)\, r^L\right) + (1-x)\, r^F - r^D\right] D + \\ &\quad (1-z)\, p\left[xr^H + (1-x)\, r^F - r^D\right] D \end{aligned} \tag{2.A.11}$$

The choice of D depends on x:

$$\frac{\partial \Pi^e}{\partial D} = pxr^H + z\,(1-p)\, xr^L + (z + (1-z)\, p)\,(1-x)\, r^F - (z + (1-z)\, p)\, r^D$$

If $\frac{\partial \Pi^e}{\partial D} > 0$ then the solution D^d is infintely high. If $\frac{\partial \Pi^e}{\partial D} = 0$, then each bank is indifferent with respect to D. If $\frac{\partial \Pi^e}{\partial D} < 0$, then $D^d = 0$.

The choice of x, in turn, depends on D^d. If $D^d = 0$, then each bank is indifferent with regards to x. If $D^d > 0$, then the choice of x is determined by the sign of the derivative

$$\frac{\partial \Pi^e}{\partial x} = pr^H + z\left(1-p\right)r^L - \left(z + \left(1-z\right)p\right)r^F$$

This expression is positive since by the Assumtion **??**

$$\begin{aligned} pr^H + \left(1-p\right)r^L &> r^F \Rightarrow \\ pr^H + \left(1-p\right)r^L - \left(1-z\right)\left(1-p\right)r^L &> r^F - \left(1-z\right)\left(1-p\right)r^L \end{aligned}$$

which implies due to the Assumption **??**

$$\begin{aligned} r^F - \left(1-z\right)\left(1-p\right)r^L &> r^F - \left(1-z\right)\left(1-p\right)r^F = \\ &= \left(z + \left(1-z\right)p\right)r^F \end{aligned}$$

and hence

$$pr^H + z\left(1-p\right)r^L > \left(z + \left(1-z\right)p\right)r^F$$

Therefore, the bank chooses $x^* = 1$ and consequently D^d is infinitely high if the objective function of the bank is still positive. Now check for the positiveness of the latter:

$$\Pi^e = \left[pr^H + z\left(1-p\right)r^L - \left(z + \left(1-z\right)p\right)r^D\right]D$$

It follows that each bank chooses $x^* = 1$ and infinitely high D^d only if $r^D < \frac{1}{z+(1-z)p} \times$ $\times \left(pr^H + z\left(1-p\right)r^L\right)$. If, however, $r^D = \frac{1}{z+(1-z)p}\left(pr^H + z\left(1-p\right)r^L\right)$, then the bank is indifferent with regards to D, but x is still $x^* = 1$, since lowering x would make the objective function strictly negative, which is not optimal. The rest is obvious.

■

Proof of Proposition **??**

Proof.

One needs to compare the equations for the deposit demand (Proposition **??**) and for the deposit supply (**??**). Consider first the possibility for the equilibrium with a positive amount of deposits with the banks. It is only possible under the interest rate $r_c^D = \frac{1}{p+z(1-p)}\left(pr^H + z\left(1-p\right)r^L\right)$. If the interest rate is higher, there is either no equilbrium or the equilbrium with a zero amount of deposits with the banks. If the interest rate is lower, there is an excess demand for deposits (the demand for deposits is infinitely high). A positive amount of deposits with the banks is only possible if $r_c^D \geq r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$. This condition implies

$$\frac{1}{p + z(1-p)} \left(pr^H + z(1-p) r^L\right) \geq r^F + \frac{(1-p)}{p} x \left(r^F - r^L\right)$$

Remember, with $r_c^D = \frac{1}{p+z(1-p)} \left(pr^H + z(1-p) r^L\right)$ the optimal choice of banks with respect to x is $x^* = 1$. Hence, the above inequality is equivalent to

$$\begin{aligned}
p^2 r^H + z(1-p) pr^L &\geq (p + z(1-p)) pr^F + (1-p)(p + z(1-p)) \left(r^F - r^L\right) \Leftrightarrow \\
p^2 r^H + z(1-p) pr^L &\geq (p + z(1-p)) r^F - (1-p)(p + z(1-p)) r^L \Leftrightarrow \\
p^2 r^H + z(1-p) pr^L &\geq (p + z(1-p)) \left(r^F - r^L\right) + p(p + z(1-p)) r^L \Leftrightarrow \\
p^2 r^H - p^2 r^L &\geq (p + z(1-p)) \left(r^F - r^L\right) \Leftrightarrow \\
\frac{p^2}{p + z(1-p)} &\geq \frac{r^F - r^L}{r^H - r^L}
\end{aligned}$$

If the last inequality is not met, the supply of deposits is zero, and hence the equilibrium amount of deposits with the banks is zero. This still meets the deposit demand $D^d \in [0, \infty)$ at the interest rate $r_c^D = \frac{1}{p+z(1-p)} \left(pr^H + z(1-p) r^L\right)$. The bank still decides for the portfolio composition $x^* = 1$, but the resulting allocation of resources in the risky asset is $X^* = 0$ due to the zero supply of deposits.

■

Chapter 3
Regulatory Forbearance and Intergenerational Workout Incentives

Banking regulators often practice forbearance in insolvency resolutions. In this chapter, I discuss a relatively simple dynamic setting, which allows one to examine the effects of regulatory forbearance. I show to what extent the results of the previous chapter can be extended to the forbearance case. Of special interest is the issue of intergenerational workout incentives, which eliminate the internalization of bailout costs on the side of the population. At the same time, the policy of forbearance may make banks internalize bailout costs.

3.1 Limited Liability versus Unlimited Liability

The theory of banking widely uses the principle of limited liability in modelling banking behavior. Although the literature on limited liability in economics is relatively large (see, for example, the review by Noe and Smith, 1997), its applications to banking are scarce. The research focuses mostly on the ideas that limited liability can give the bankers incentives to take too much risk (e.g. Gollier, Koehl and Rochet, 1996) and/or lead to the excessive interest rates if intermediation is competitive (e.g. Matutes and Vives, 2000). Other effects of limited liability as well as the question to what extent the principle of limited liability holds in practice, suffer a certain lack of attention.

Sinn (2003) defines unlimited liability as the case, in which "banks will always keep their promises", but adds that "unlimited liability is far from being realistic, given that no one can lose more than he has." In a static context, this is obvious. Indeed, consider for an instance a standard two-period setting like the one used in Chapter 2. In the first period, a depositor decides whether to deposit with the bank or not, while the bank decides upon its investment portfolio. In the second period, two states of nature are possible: either the bank is solvent or not. If the bank is solvent, the depositor is repaid in full. If the bank is insolvent, the depositor can be repaid with no more than the value of the bank's portfolio. In this world, there is no place for unlimited liability, which supports the above idea of Sinn (2003).

Consider now a world with overlapping generations, where the bank can exist for many periods. In each period, a new generation of depositors decides upon depositing with the bank. Over a period, two states of nature are possible: either the bank is solvent or not. If the bank is solvent, old depositors are repaid in full. However, if the bank is insolvent, it can still be liquid due to the deposits acquired from the new generation of depositors. Old depositors can be repaid from these newly acquired funds. This would be the case of unlimited liability in line with the definition of Sinn (2003). The question is whether the bank is *allowed* to repay to the old depositors in case of its insolvency.

An even more important question is whether the agents *expect* the bank to be allowed to do so. The reason lies in the fact that the principle of limited or unlimited liability is used as the basis for the discussion of *expected* payoffs, which determine the decisions of agents in the first period in both of the above mentioned examples. Hence, the unlimited bank liability should not be seen as the case, in which "the lender gets exactly what the bank promises" (Sinn, 2003), but rather as the case, in which the banks *expect* to be able to do so, and lenders (depositors) expect the banks to be able to repay. Therefore, the discussion of the principle of limited or unlimited liability crucially depends on the expectations (or beliefs) of agents.

In the previous chapter, I showed that the difference in the views of bankers and depositors with regard to this question could be an obstacle for the efficiency of banking in a static context. In order to introduce unlimited liability into the model, I suggested that the banks maximize the objective function, which is effectively the expected payoff of their shareholders. Under this assumption, if the shareholders have to pay taxes in order to enable the regulator to subsidize the bank in case of its insolvency, the bank internalizes the costs of bailouts exactly as it should be in a world with unlimited liability.

In this chapter, I extend the model into a dynamic context in order to more plausibly justify unlimited liability. Moreover, the dynamic setting makes it possible to study regulatory forbearance, which is another puzzle of the actual banking regulation along with constructive ambiguity, which has been discussed in the previous chapter.

3.2 Ambiguity and Forbearance

In the previous chapter (Section 2.1), I discussed common approaches to resolutions of banks failures. Besides the choice of the resolution procedure (liquidation, open bank assistance through loans or subsidies, mergers etc.), the question whether the regulatory institution commits to a certain resolution rule is also of great importance. A simple example of such a rule may be the commitment of the regulator to liquidate insolvent banks. In such a case, the banking sector provides the same allocation of households' resources in risky and risk-free investment projects as the households themselves would choose, if they had an opportunity to buy risky and risk-free assets directly in a financial market. However, if the regulator does not commit to the liquidation of insolvent banks, an asymmetry in beliefs of the households and bankers may arise with respect to whether insolvent banks are liquidated or bailed out. If the households believe insolvent banks will be liquidated, and the bankers believe them to be bailed out, a situation may appear, in which the banking system provides a different allocation of resources in risky and riskless projects than the one in the market-based economy. Banks internalize bailout costs and may allocate the whole amount of deposits collected from the households in the riskless asset, although the households themselves would choose to invest their whole endowment in the risky asset, if they could buy it directly in the market. Another extreme case is disintermediation, when the households do not deposit with banks but rather invest their whole endowment in the risk-free asset.

Hence, on the one hand, the ambiguity in the bailout policy may be harmful for the economy. On the other hand, a commitment to a certain bailout rule may increase moral hazard in banking. Though I do not model moral hazard explicitly, an example from Chapter 2 shows that if a regulator commits to liquidation, banks do not internalize liquidation costs, and this may lead to excessive deposit interest rates in a competitive banking sector. A solution of the dilemma may be seen in an uncertain (stochastic) bailout rule, within which the regulator announces a probability z, with which the banks would be bailed out. Such a rule preserves internalization of liquidation (and bailout) costs by banks and provides a possible justification of the policy of "constructive ambiguity" as defined by Enoch, Stella and Khamis (1997).

Another feature of the actual bailout policies around the world is a regulatory forbearance. The forbearance presumes a delay in implementing a resolution procedure in case of the insolvency of a banking institution. Bennett (2001) writes:

> *”an insolvent bank is more likely to continue to operate in developing economies or economies in transition: one half of the respondents [local banking regulators - D.V.] in this group have allowed insolvent banks to operate, whereas 3 of the 14 deposit insurers in advanced economies have done so”.*

In general, 35% of respondents (10 out of 28) did not deny the practice of allowing equity-insolvent depository institutions to operate for extended periods. Just one example in this connection is that during a 4 year period (1988-92) the FDIC allowed the insolvent First City Bancorporation (with 59 branches in USA) to operate through open bank assistance, and only in 1992 did the recurring losses of the bank led to its closure. Santomero and Hoffman (1998) also note that regulators often delay resolution actions in the hope of a turnaround.

In the two-period setting in the previous chapter, it was impossible to study the effects of forbearance. To model the bailout policy, I introduced a subsidy to an insolvent bank, which is financed through taxes from the population. In such a setting, the taxpayers do not actually perceive a bailout as a rescue of the bank, since the bailout is performed at their expence. As a result, depositors face the same final payoff, no matter if the insolvent bank is bailed out or liquidated. Indeed, if an insolvent bank is liquidated, the depositors obtain it’s portfolio value as a payoff. If an insolvent bank is bailed out, the depositors obtain deposits repaid in full, but have to pay taxes to cover the gap between the value of the bank’s portfolio and the amount repaid on deposits, so that the net payoff is the same as in the case of the liquidation of the bank.

A possibility to relax this assumption of a complete internalization of bailout costs by the depositors could be seen in distinguishing between shareholders and non-shareholders of the banks. If only shareholders have to pay a tax (or a fee) to provide for the subsidy to bail an insolvent bank out, the non-shareholders would not internalize such costs and their deposit supply would differ from the one derived in the previous chapter. The internalization of bailout costs by depositors would disappear, if the share of the shareholders in the whole population is infinitesimal, . Nonetheless, if banks are concerned with the expected payoff to their shareholders - who still have to pay a tax to provide funds for the subsidy in case of the banks' insolvency - then they would still internalize bailout costs

Another possibility to achieve the same effect arises in a dynamic setting, if intergenerational workout incentives are present. In some cases, the literature stresses the difference between "bailouts" and "workouts" (see e.g. Portes, 1998, and Haldane, Irwin and Saporta, 2004), with bailouts referring to rescue packages and workouts referring to bankruptcy procedures. In the two-period setting in the previous chapter, only liquidation or subsidization was considered as a possible insolvency resolution, so that one could clearly distinguish between "bailouts" and "workouts". However, if one considers other bankruptcy procedures (see Chapter 2, Section 2.1.1), like bridge bank or mergers and acquisitions, they do not result in the liquidation of an insolvent bank, but rather presume the continuation of its activities. In such cases, it is more convenient to use the broader term "workouts". In a dynamic setting, following Gersbach and Wenzelburger (2002 b), I define workout incentives of future generations as the attitude of the generation (or some generations) that follows the one currently depositing with a bank, to provide the insolvent bank with a possibility of continuation. This broad formulation encompasses different failure resolution procedures, including, but not restricted to bailouts.

In this chapter, I first extend the concept of subsidies developed in the two-period model in the previous chapter. In a dynamic setting, it is possible that the regulator collects taxes needed to subsidize the insolvent bank from the new generation, instead of charging those who are currently the depositors of the bank. In such a case, the depositors of the bank do not internalize the costs of the bailout.

Secondly, I consider the possibility for regulatory forbearance. In a dynamic setting, in contrast to the two-period one, it is possible that an insolvent bank obtains deposits from a new generation of depositors and can use them to repay the previous generation of depositors.

Workout incentives make this possible, since each generation of depositors believes that the next generation would let the bank continue to operate and thus provide an implicit guarantee for the deposits.

3.3 Macroeconomic Environment in a Dynamic Context

Up to this point I have studied a partial equilibrium model to analyze the effect of the bailout policy on the allocation of funds between risky and risk-free alternatives. To create a better understanding of some assumptions, I now suggest a dynamic extension of this model.

Consider an economy in which a continuum of agents live for two periods, as before. A generation t of the agents is born in the beginning of the period t and is endowed with a unit amount of the consumption-investment good. This generation is young in the period t, becomes old in the beginning of the period $t+1$ and dies in the end of the period $t+1$. In each period, one generation is born.

Each generation consists of potential entrepreneurs and of consumers. It is convenient to normalize the mass of each group of agents to unity. The entrepreneurs differ from the consumers in that the former have access to a production technology Ψ, and the latter do not. The production technology is risky and has a constant state-contingent return to scale (see e.g. Eichberger and Harper, 1997, Ch. 1, for a brief discussion of the state-contingent production functions in the framework of the decision-making under uncertainty). In each period $t+1$, one of two states of nature $\mathbf{s}_{t+1}$, "H" or "L", is possible, and if k_t units of good are invested in the period t, the production technology delivers $\left(1+r^H\right)k_t$ units of good in the "H"-state of nature and $\left(1+r^L\right)k_t$ units of good in the"L"-state of nature in the period $t+1$:

$$\Psi\left(k_t,\mathbf{s}_{t+1}\right)=\begin{cases}\left(1+r^H\right)k_t & \text{if} \quad \mathbf{s}_{t+1}=H\\ \left(1+r^L\right)k_t & \text{if} \quad \mathbf{s}_{t+1}=L\end{cases}$$

As before, the probability of the "H"-state of nature is p, and the probability of the "L"-state of nature is $(1-p)$, and both are constant over time. The state-contingent rates of return r^F and r^L, induced by the production technology are also constant over time. It is easy to see that the production technology is an analogy to the risky asset in the formulation of the previous chapter.

Furthermore, a storage technology also exists, which allows one to transfer funds from a period t into the period $t+1$, and yields a risk-free rate of return r^F, which is also constant over time. The risk-free storage technology is available to both entrepreneurs and consumers. As before, I assume

$$r^H > r^F > r^L \tag{A-3-1}$$

and

$$pr^H + (1-p)r^L > r^F \tag{A-3-2}$$

Again, the first assumption guarantees that neither technology is preferred to another one *a priori*. The second assumption states that the production technology is preferred to the storage technology *in terms of expected values*.

Finally, assume that all agents only care about consumption when old. This reduces their decision-making to maximization of the gains in the second period of their lives from their investment made in the first period of their lives.

3.4 Market Economy

Assume there exists a market place in which potential entrepreneurs and consumers can negotiate at no costs.

3.4.1 Entrepreneurs

To make the model as close as possible to the one in the previous chapter, assume that the entrepreneurs offer the consumers an opportunity to share the usage of the production technology. The entrepreneurs charge the consumers a proportional fee $\gamma_t \geq 0$ for the access to the production technology. As a result, if a consumer delivers x_t units of the good to the entrepreneur for investment, only $(1-\gamma_t)\,x_t$ units are invested on behalf of the consumer, while the rest of $\gamma_t x_t$ belongs to the entrepreneur.

Hence, each entrepreneur possesses a total of $m_t = 1 + \gamma_t x_t$ units of good for investment and has an opportunity to invest a share y_t of it into the risky production technology, and the share $(1-y_t)$ into the storage technology with no risk. The entrepreneurs maximize the profit they expect to obtain in the period $t+1$:

$$E^e_{t+1} = p\left(1+r^H\right)y_t\left(1+\gamma_t x_t\right)+(1-p)\left(1+r^L\right)y_t\left(1+\gamma_t x_t\right) + \left(1+r^F\right)\left(1-y_t\right)\left(1+\gamma_t x_t\right)$$

The decision-making of the entrepreneur depends on x_t as well as on y_t:

$$\begin{aligned} E^e_{t+1} &\rightarrow \max_{y_t, x_t} \\ \text{s.t.} \quad & 0 \leq y_t \leq 1 \\ & x_t \geq 0 \end{aligned} \tag{3.1}$$

The expected profit function is linear in y_t and in x_t. The solution of optimization problem (**??**) depends on the signs of the partial derivatives of the expected profit function

$$\frac{\partial E^e_{t+1}}{\partial y_t} = p\left(1+r^H\right)\left(1+\gamma_t x_t\right)+(1-p)\left(1+r^L\right)\left(1+\gamma_t x_t\right)-\left(1+r^F\right)\left(1+\gamma_t x_t\right)$$

and

$$\frac{\partial E^e_{t+1}}{\partial x_t} = p\left(1+r^H\right)y_t\gamma_t+(1-p)\left(1+r^L\right)y_t\gamma_t+\left(1+r^F\right)(1-y_t)\gamma_t$$

Since $x_t \geq 0$ and $\gamma_t \geq 0$ and due to the Assumption (**??**), we obtain $\frac{\partial E^e_{t+1}}{\partial y_t} > 0$, which implies the optimal choice of $y^*_t = 1$. This implies, in turn, that the optimal choice of x_t depends on γ_t:

$$\frac{\partial E^e_{t+1}}{\partial x_t} = \left[p\left(1+r^H\right)+(1-p)\left(1+r^L\right)\right]\gamma_t \gtreqqless 0 \text{ if } \gamma_t \gtreqqless 0$$

This leads to the following decision by the entrepreneurs:

$$y^*_t = 1 \tag{3.2}$$

$$x^d_t \in \begin{cases} \{\infty\} & \text{if } \gamma_t > 0 \\ [0;\infty) & \text{if } \gamma_t = 0 \end{cases} \tag{3.3}$$

Here x^d_t denotes the demand of the entrepreneurs for the external funds, which depends on the fee γ_t. The aggregate demand for the external funds from the side of all entrepreneurs $X^d_t\left(\gamma_t\right) = \int\limits_0^1 x^d_t\left(\gamma_t\right)di = x^d_t\left(\gamma_t\right)$ is also indefinite.[27]

[27] Since all entrepreneurs are equal, I omitted the index i related to an individual entrepreneur everywhere in the text. The appearance of i in the integration only aims to show that we sum individial demands over all entrepreneurs.

3.4.2 Consumers

The consumers decide upon the allocation of their unit endowment of funds in the following parts: x_t for the production technology, which is accessible thank to the entrepreneurs, and $(1 - x_t)$ for the safe storage technology. Given the fee, γ_t, charged by the entrepeneurs, the expected profit function of the consumers is

$$G_{t+1}^e = p\left(1 + r^H\right)(1 - \gamma_t)\, x_t + (1 - p)\left(1 + r^L\right)(1 - \gamma_t)\, x_t + (1 - x_t)\left(1 + r^F\right)$$

and the corresponding opitmization problem is

$$\begin{array}{lcl} G_{t+1}^e & \to & \max\limits_{x_t} \\ \text{s.t.} & & 0 \leq x_t \leq 1 \end{array} \tag{3.4}$$

The first derivative of the expected profit function is

$$\frac{\partial G_{t+1}^e}{\partial x_t} = \left[p\left(1 + r^H\right) + (1 - p)\left(1 + r^L\right)\right](1 - \gamma_t) - \left(1 + r^F\right)$$

Obviously, the solution of the optimization problem is

$$x_t^s \in \begin{cases} \{0\} & \text{if} \quad \gamma_t > \frac{pr^H + (1-p)r^L - r^F}{1 + pr^H + (1-p)r^L} \\ [0;1] & \text{if} \quad \gamma_t = \frac{pr^H + (1-p)r^L - r^F}{1 + pr^H + (1-p)r^L} \\ \{1\} & \text{if} \quad \gamma_t < \frac{pr^H + (1-p)r^L - r^F}{1 + pr^H + (1-p)r^L} \end{cases}$$

The total amount of funds supplied by all consumers to the entrepreneurs to invest into the production technology is $X_t^s(\gamma_t) = \int\limits_0^1 x_t^s(\gamma_t)\, di = x_t^s(\gamma_t)$.

3.4.3 Equilibrium

Now we can find the temporary equilibrium in this economy for any period t.

Definition 3.1 A temporary equilibrium in a period t is an allocation of funds X_t^* and the fee γ_t^* such that $X_t^* = X_t^d(\gamma_t^*) = X_t^s(\gamma_t^*)$

It is easy to see that under a strictly positive fee γ_t the demand for external funds from the side of the entrepreneurs is infinitely high, but the supply of funds from the side of consumers is limited to unity. The only possibility for the equilibrium is $\gamma_t^* = 0$, which means that the entrepreneurs provide the consumers with a free of charge access to the production technology. At the same time, the equilibrium allocation of funds is $X_t^* = 1$, which means that the

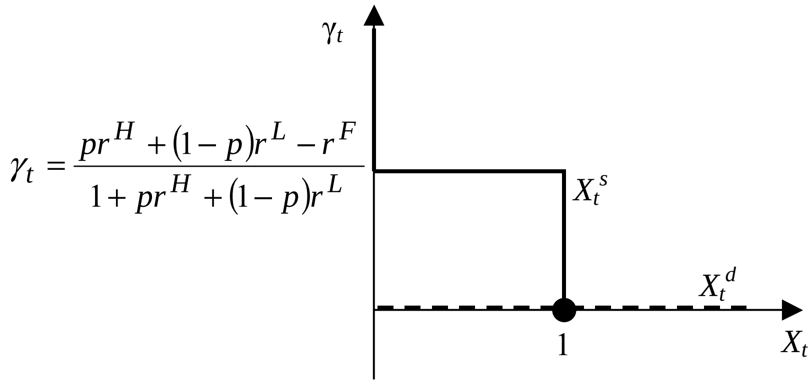

Figure 3.1. Equilibrium in the market economy

consumers invest their whole initial endowment in the risky technology. This equilibrium constellation does not depend on the index of the period t, and persists over time.

Graphically, the equilibrium is presented in Figure **??**. The supply of funds X_t^s in any period t is absolutely elastic at the fee $\gamma_t = \frac{pr^H+(1-p)r^L-r^F}{1+pr^H+(1-p)r^L}$, is zero for higher levels of the fee and is unity for the lower levels of the fee. The demand for funds X_t^d in any period t is absolutely elastic at the fee level $\gamma_t = 0$. Remember that the demand for funds may be interpreted as a supply of the risky asset, as formulated in the previous chapter, in which the supply of the risky asset was assumed to be absolutely price-elastic. The example above justifies this assumption.

Corollary 3.1 *In the market economy, the consumers of each generation t invest their complete initial endowment in the risky technology.*

In the following, I will introduce financial intermediation into the economy and concentrate on the deposit market equilibrium and the resulting allocation of funds in the risky technology. I will use the result above and assume henceforth in this chapter that the access to the risky technology is free of charge. Since the demand for funds on the side of entrepreneurs is absolutely price-elastic, we will only need to study the supply of funds, or equilvalently the demand for the risky asset, to obtain the equilibrium allocation X_t^* of funds in the risky investment project.

3.5 Intermediated economy

Assume the market place described above does not exist, or the access to it induces high transaction costs for the agents.[28] This justifies the existence of financial intermediaries. Assume, financial intermediation is present in the model in the form of banks, which belong to consumers in equal shares, and the property rights are transferred from generation to generation through bequests.

3.5.1 Bailouts

Assume there exists a regulatory authority which is responsible for bailouts or liquidation of banks. A bailout presumes paying out the debts of the bank to depositors in order to save the bank and continue its charter. Liquidation means selling bank's assets in case of its insolvency and transferring the proceeds to the depositors indemnifying the banks' debts.

If in a period $t+1$ a bank is insolvent, the regulator may opt to bail it out. To do this, the regulator collects taxes from the generation $t+1$ and subsidizes the bank so that the bank obtains enough funds to repay the depositors of generation t. This organization of bailouts differs from the one studied in the previous chapter, in which the costs of the bailout were borne by the generation which was depositing with the bank. Now depositors do not internalize the costs of the bailout.

In general, the regulator does not promise to save the banks unambiguously, but rather announces some probability of bailouts z. As shown in the previous chapter, setting $z = 1$ leads to the case, in which the regulator commits to bailouts. If $z \to 0$, we obtain a case similar to the commitment to liquidation, but not exactly equivalent to it. The principal difference of the commitment-to-liquidation case is that the banks do not internalize the costs of bailouts at all, which results, for example, in excessively high deposit interest rates in the competitive banking sector.

As in the previous chapter, I consider the case of unconditional bailouts, when the regulator saves the banks with probability z in case of their insolvency, but independently of the

[28] A special example for such costs would be an asymmetry of information, such that an agent i does not know whether another agent j is entrepreneur or consumer, but can obtain this information at some costs. This would make finding a counterpart for a loan contract costly.

state of nature.

3.5.2 Sequence of events

Consider two subsequent periods $t-1$ and t. In period $t-1$, consumers of the generation $t-1$ decide upon the composition of their investment portfolio: a part a_{t-1} of their unit initial endowment is deposited with a bank, and a part $(1-a_{t-1})$ is invested in the risk-free asset. Simultaneously, the bank decides upon the amount of deposits D_{t-1} it wants to collect at an interest rate r_t^D (this is the interest rate, which determines the repayment to the depositors in the period t, this explains why the time-index is t instead of $t-1$), and upon the optimal composition of its financial portfolio: a share x_{t-1} of the collected deposits is invested in the risky production technology, as described above for the market case, and a share $(1-x_{t-1})$ is invested in the risk-free asset.

At the end of the period $t-1$, production takes place and yields the rate of return of r^H in the beginning of the period t if the "H"-state of nature is realized and the rate of return r^L if the "L"-state of nature is realized. In the beginning of the period t, the state of nature for this period is known to all agents.

If portfolio gains of the bank in the period t are not below the total amount due to depositors of period $t-1$, the bank is solvent. The bank repays on deposits of period $t-1$ and pays any accruing dividends to its shareholders of generation $t-1$. The property rights are transferred from the generation $t-1$ to the generation t. Consumers of generation t make their decisions similarly to their predecessors in period $t-1$ as described above and deposit with the bank. Finally, the bank invests in the production technology, and the economy proceeds to period $t+1$.

If the portfolio gains of the bank in the period t are below total amount to be repaid to the depositors of generation $t-1$, the bank is insolvent. An insolvency resolution takes place. If the bank is liquidated, the value of its portfolio is transferred to the depositors of generation $t-1$ in equal shares as in the two-period model in the previous chapter. In case of the liquidation of a bank, a new bank is immediately created to replace the liquidated one. The new bank belongs to the consumers of generation t, which repeat the decision-making of the preceeding generation. The bank invests and the economy proceeds to period $t+1$.

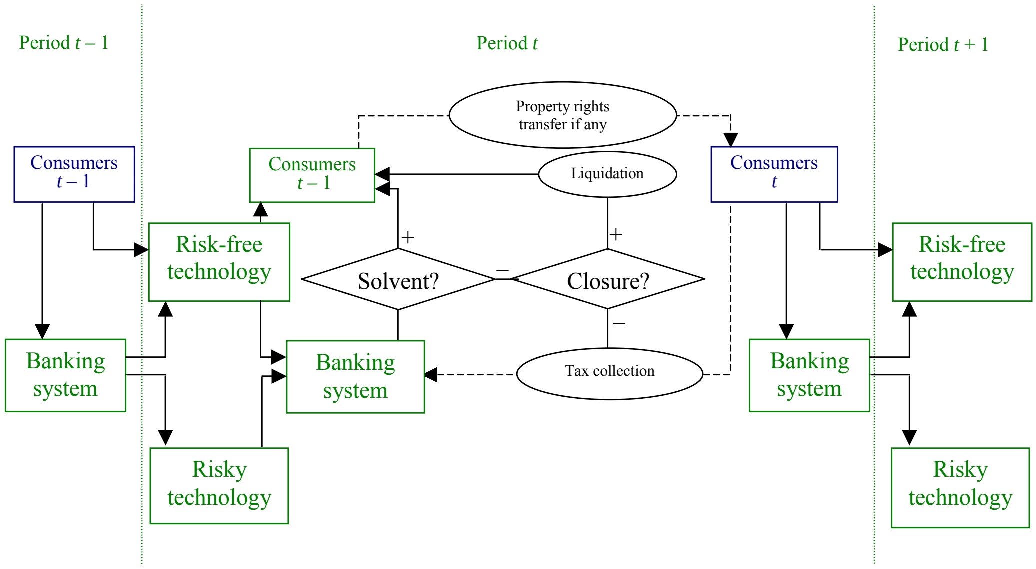

Figure 3.2. Sequence of events in intermediated economy

If the insolvent bank is not liquidated, it is bailed out through a subsidy. The regulator collects taxes from the generation t to subsidize the bank in the period t. The bank repays the depositors of generation $t-1$. The property rights are transferred to generation t, the decision-making takes place as above, the bank invests and the economy proceeds to period $t+1$.

The sequence of events is presented in Figure **??**. The entrepreneurs are not shown in the figure since, as previously established, they provide a free of charge access to the risky technology. The consumers do not have access to the risky technology, since the search for an entrepreneur is costly. The banking system has a cost advantage and has access to the risky technology. After the consumers of generation $t-1$ have invested in the risk-free technology and in a deposit contract, and after the banks have invested in the risk-free and risky technology, production takes place and the new period begins, in which the state of nature is realized. The rhombi in Figure **??** denote the nodes, in which the development of events can follow different scenarios. The first rhombus determines the first scenario (a solvent bank repays its depositors) and the way to the second and third scenarios (if the bank is insolvent). The second rhombus distinguishes between the second scenario (an insolvent bank is bailed out through a subsidy financed via taxes collected from the consumers of the new generation) and the third scenario (an insolvent bank is liquidated). If the bank is subsidized, the arrow leads back to the solvency-check rhombus. After the bank has obtained the subsidy, it is able to repay its depositors of generation $t-1$, and, hence, is solvent. Further events develop as in the case of solvency: the property rights are transferred from the generation $t-1$ to the generation t. If the bank is liquidated, its value is paid to the depositors of generation $t-1$, and no property rights can be transferred to generation $t+1$. However, in the latter case, generation t establishes a new banking system so that in all three scenarios, there is again a banking system which belongs to generation t. The consumers of generation t deposit and invest in the risk-free technology. The banking system invests and the events repeat.

In Figure **??**, the banking system in period t is split into two parts: first, into the banking system, which still belongs to the old generation (generation $t-1$), and secondly, into the banking system, which belongs to the new generation t. If the banking system is solvent, the rhombus "Solvent?" switches to "+", the deposits of generation $t-1$ are repaid, and members of generation $t-1$ transfer their property rights to generation t. As a result, the banking system now belongs to the generation t. If the banking system is insolvent, the rhombus "Solvent?" switches to "-", and the decision regarding closure is made. If the regulator decides to liquidate the banks, the rhombus "Closure?" switches to "+", and the consumers of generation $t-1$ obtain the portfolio value of the banks. Liquidation cancels the property rights so that generation $t-1$ cannot transfer any property rights to generation t. Generation t has to create a new banking system with which it deposits. Finally, if the regulator decides to bail the banks out, the rhombus "Closure?" switches to "-", and taxes are collected from generation t, which is shown with the respective dashed arrow. Note that this flow of funds is only possible if the rhombus "Closure?" is switched to "-". Otherwise, the oval "Tax collection" is not switched on, and the dashed arrow corresponding to the taxation and subsidization is interrupted. If the banks obtain the subsidy, the rhombus "Solvent?" is switched to "+" so that the flow of funds to the consumers of generation $t-1$ is now possible, and they obtain their deposits repaid in full. They can now transfer the property rights to generation t so that the same banking system belongs now to generation t.

3.6 Intermediated Economy: No Internalization of Bailout Costs

If the banks in period $t+1$ are not able to repay all their debts to the depositors of generation t, the regulator can intervene and bail the banks out. If the bailout is performed (which probability is z), depositors receive their deposits in full with interest accrued. If, however, the bailout is not performed, the banks are liquidated and the repayment to depositors are determined by the value of banks' assets in period $t+1$. Depositors are informed about the values of p, z and the share of the risky asset in banks' portfolios x_t so that they can form expectations about future repayments on deposits, given the announced deposit rate r_{t+1}^{D}. We can again find the probability of the event that the depositors are paid in full.

Lemma 3.1 Given the parameters r^H, r^F, r^L and p and the probability of bailout z, the probability ρ, with which depositors are repaid in full, is a function of r_{t+1}^{D} and x_t:

$$\rho\left(x_t; r_{t+1}^{D}\right) = \begin{cases} z & \text{if} \quad r_{t+1}^{D} > \widetilde{r}_{t+1}^{H} \\ p + (1-p)\, z & \text{if} \quad \widetilde{r}_{t+1}^{H} \geq r_{t+1}^{D} > \widetilde{r}_{t+1}^{L} \\ 1 & \text{if} \quad r_{t+1}^{D} \leq \widetilde{r}_{t+1}^{L} \end{cases} \tag{3.5}$$

The notation is inherited from Chapter 2, with the only change being the time index. In this dissertation, the time index for the interest rates denotes the period, when the payment is due. Hence, the state-contingent rate of return $\widetilde{r}_{t+1}^{\mathbf{s}_{t+1}}$ ($\mathbf{s}_{t+1} \in \{H, L\}$) is the rate of return, which the bank obtains in period $t+1$ on the investment made in period t in a financial portfolio with the share x_t invested into the risky technology and $(1-x_t)$ invested into the risk-free one:

$$\begin{array}{lll} \widetilde{r}_{t+1}^{H} = x_t r^H + (1-x_t)\, r^F & \text{if} & \text{"H"-state} \\ \widetilde{r}_{t+1}^{L} = x_t r^L + (1-x_t)\, r^F & \text{if} & \text{"L"-state} \end{array} \tag{3.6}$$

Remember, r^H and r^L are parameters and do not change over time.

Note that the consumers of generation t do not internalize the bailout costs. Hence, the probability $\rho\left(x_t; r_{t+1}^{D}\right)$ describes the probability of obtaining the total payoff in period $t+1$ with the rate of return r_{t+1}^{D}. Previously, the depositors internalized the costs of bailouts, and hence accounted as well for the taxes, which they would have to pay in case of the insolvency of the bank and its consequent bailout through subsidization. The fact that depositors do not internalize the bailout costs, changes their demand for deposits. One can expect that in case of no internalization of costs, depositors are less cautionary in their behavior, and,

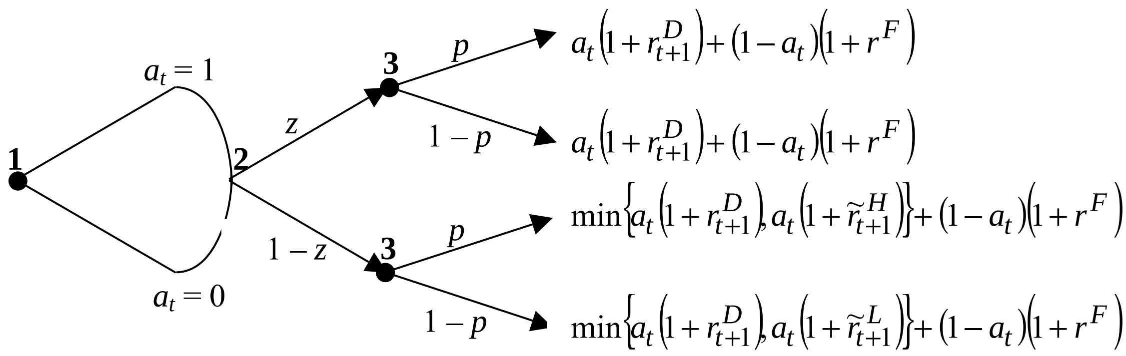

Figure 3.3. Decision-making of the consumers of the generation t.

hence, the disintermediation may disappear, which also eliminates the inefficiency of the intermediation.

Consider now decisions made by the agents in case the regulator announces unconditional bailouts policy in period t: no matter what the state of the nature in period $t+1$ is, banks are bailed out with probability z.

3.6.1 Supply of Deposits

Again, consumers maximize their expected gains from investing into the risk-free technology and into a deposit contract at the interest rate r^D_{t+1}. Their optimization problem is as follows

$$\begin{array}{ccc} G^e_{t+1} & \rightarrow & \max\limits_{a_t} \\ \text{s.t.} & & 0 \leq a_t \leq 1 \end{array} \tag{3.7}$$

with

$$\begin{aligned} G^e_{t+1} &= za_t\left(1+r^D_{t+1}\right)+p\left(1-z\right)\min\left\{a_t\left(1+r^D_{t+1}\right);a_t\left(1+\tilde{r}^H_{t+1}\right)\right\}+ \\ &\quad \left(1-p\right)\left(1-z\right)\min\left\{a_t\left(1+r^D_{t+1}\right);a_t\left(1+\tilde{r}^L_{t+1}\right)\right\}+\left(1-a_t\right)\left(1+r^F\right) \end{aligned}$$

This expected gains function results from the decision-making of the consumers depicted in Figure **??**. As in the previous chapter, the continuum of the possible actions of the consumers in node 1 is shown with the arc connecting the two edges starting in node 1. In node 2, the regulator decides whether to bailout the failing banks or not, with the probability of the bailout z. In node 3, the state of nature $\mathbf{s}_{t+1}$ for the period $t+1$ is realized. In the end nodes one can see the payoff to the consumers, which is either $a_t\left(1+r^D_{t+1}\right)+(1-a_t)\left(1+r^F\right)$ independent of the state of nature if the regulator bails the insolvent banks out, or $\min\left\{a_t\left(1+r^D_{t+1}\right);a_t\left(1+\widetilde{r}^{\mathbf{s}_{t+1}}_{t+1}\right)\right\}+(1-a_t)\left(1+r^F\right)$, if the insolvent banks are liquidated. The term $\min\left\{a_t\left(1+r^D_{t+1}\right);a_t\left(1+\widetilde{r}^{\mathbf{s}_{t+1}}_{t+1}\right)\right\}$ means that the payoff of the deposit of the size a_t is either $a_t\left(1+r^D_{t+1}\right)$ if the bank is solvent, or $a_t\left(1+\widetilde{r}^{\mathbf{s}_{t+1}}_{t+1}\right)$ if the bank is insolvent.

Optimization problem (**??**) determines the optimal share a_t^* of deposits in the portfolio of consumers. Remember, the group of consumers has a unit mass and may be thought as being distributed on the interval $[0;1]$. Each consumer possesses a unit initial endowment. Total (aggregate) supply of deposits in the economy in the period t is then

$$D_t^s=\int_0^1 a_t^* di=a_t^* \tag{3.8}$$

Proposition 3.1 *If the regulator follows a rule of bailing the banks out with probability z, and if the bailout costs are not internalized by the depositors, the aggregate deposit supply in the economy is given by the function*

$$D_t^s\left(r^D_{t+1},x_t\right)=\begin{cases}1 & \textit{if} \quad r^D_{t+1}\geq r^F+\frac{(1-p)(1-z)}{p+z(1-p)}x_t\left(r^F-r^L\right)\\ 0 & \textit{if} \quad r^D_{t+1}< r^F+\frac{(1-p)(1-z)}{p+z(1-p)}x_t\left(r^F-r^L\right)\end{cases} \tag{3.9}$$

Remember from the previous chapter that if the regulator saves the banks at costs of their shareholders, the deposit supply was zero as soon as the deposit interest rate was below $r^F+\frac{(1-p)}{p}x_t\left(r^F-r^L\right)$. Obviously, $\frac{(1-p)(1-z)}{p+z(1-p)}<\frac{(1-p)}{p}$.[29] Therefore, if the depositors do not internalize the costs of bailouts, they require a smaller interest rate difference $r^D_{t+1}-r^F$ from the banks in order to deposit the whole unit edowment, than if they internalize such costs. Again, if the banks decide to invest all collected funds into the risk-free technology ($x_t=0$), depositors face a zero interest rate difference, and $r^D_{t+1}=r^F$, but according to the assumption A-2-3 from the previous chapter, they still deposit the whole their endowment with the bank.[30]

29 Multiplying both sides of the inequality in the text with $\frac{p+z(1-p)}{1-p}$ yields $1-z<1+z\frac{1-p}{p}$, which is evident.

30 This was a simplifying assumption justified through infinitesimal costs of access to the risk-free investment project.

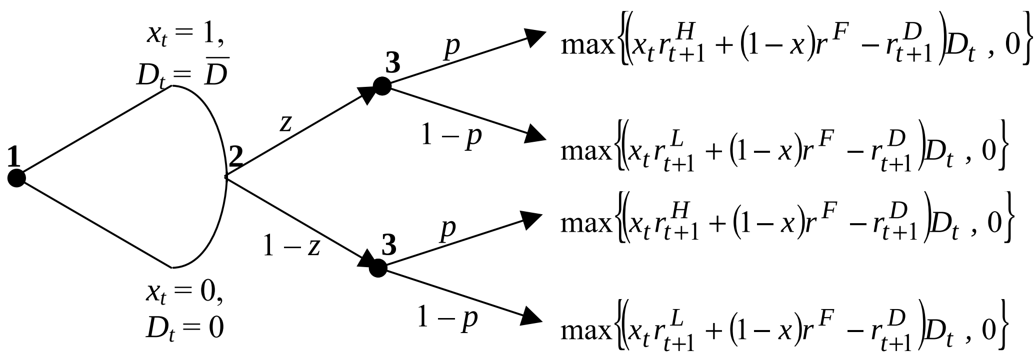

Figure 3.4. Decision-making of the banks, if the regulator bails insolvent banks out with probability z at costs of the next generation.

3.6.2 Objective Function of the Banks

If bailouts are performed with the probability z at the expense of future generations, the banks again do not internalize the costs of bailouts. Indeed, if the banks maximize the gains of their current shareholders[31], they neglect the costs of bailouts, which are borne by the agents, who at the moment of possible dividend payoffs are not the shareholders. We again face the limited liability of banks. The decision-tree of the banks in this case is depicted in Figure **??** with the same notational convention as before. In node 1, the banks decide upon their portfolio composition x_t and the amount of deposits D_t they wish to collect at the interest rate r_{t+1}^{D}.[32] In node 2, the regulator decides upon rescue or liquidation of the insolvent banks, and the decision in favour of the bailout falls with the probability z. In node 3, the state of nature is realized. The state-contingent payoffs to the bank (and therefore to its shareholders) are shown in the end nodes. It should only be noted that if the bank is insolvent and subsidized, the profit of the bank and consequently the dividend payment is zero.

The objective function of the bank is therefore the same as when the regulator commits to liquidate insolvent banks:

$$\begin{aligned} \Pi_{t+1}^{e} &= p \max\left[\left(x_t r^{H} + (1 - x_t) r^{F} - r_{t+1}^{D}\right) D_t; 0\right] + \\ &\quad + (1 - p) \max\left[\left(x_t r^{L} + (1 - x_t) r^{F} - r_{t+1}^{D}\right) D_t; 0\right] \end{aligned} \tag{3.10}$$

Therefore, we can directly apply Proposition 2.2 and Proposition 2.4 to determine the

[31] This explains the myopic behaviour of the banks.
[32] The monopolistic bank can also decide upon the deposit interest rate. Competitive banks are price-takers.

demand for deposits by both the monopolistic bank and competitive banks. This will allow one to find the respective equilibria.

3.6.3 Monopolistic Equilibrium

In a dynamic setting, several concepts of equilibrium may be applied, which I discuss in Chapter 4. In the current chapter, I focus on the temporary equilibrium, which describes the allocation of funds in a given period t. Remember that the market economy in Section **??** is a reference point for evaluating the efficiency of the allocation of resources achieved in the intermediated economy. Of primary interest is, whether the intermediated economy provides the link between creditors (consumers) and borrowers (entrepreneurs). If the allocation achieved in the intermediated economy ensures the unit aggregate investment in the risky technology, as it is in the market economy, it may be said that the intermediation is efficient.

Remember from Section **??** that the entrepreneurs provide a free of charge access to the risky technology. There is no longer a need to explicitly model the market for the contracts between entrepreneurs and external users of the risky technology. The supply of such contracts is absolutely price-elastic at the zero fee. Hence, the equilibrium in the market for such contracts is determined by the demand for them, as given by the portfolio composition of the bank.

As in the previous chapter, the monopolistic bank maximizes its objective function Π_t^e and chooses the portfolio composition x_t, optimal amount of deposits D_t and the deposit interest rate r_{t+1}^D:

$$\begin{aligned} \Pi_{t+1}^e \quad &\rightarrow \quad \max_{x_t, D_t, r_t^D} \\ \text{s.t.} \quad &\quad 0 \leq x_t \leq 1 \\ &\quad 0 \leq D_t \leq D_t^s\left(r_{t+1}^D, x_t\right) \end{aligned} \tag{3.11}$$

with the objective function given by (**??**).

Definition 3.2 Temporary monopolistic equilibrium in the period t under parameters $\left(p; r^F;\right.$ $\left.r^H; r^L\right)$ is the allocatioin-price tuple $\left(X_t^*, D_t^*, r_{m,t+1}^D\right)$, which provides

(1) $X_t^* = x_t^* D_t^d\left(r_{m,t+1}^D; x_t^*\right)$ with $(x_t^*; D_t^d; r_{m,t+1}^D) \in \arg\max \Pi_t^e$

(2) $D_t^s(r_{m,t+1}^D; x_t^*) = a_t^* \in \arg\max G_t^e$

(3) $D_t^* = D_t^d\left(r_{m,t+1}^D; x_t^*\right) = D_t^s\left(r_{m,t+1}^D; x_t^*\right)$

The definition of equilibrium requires that both actors (the bank and the households) are in their respective optima in the period t. The optimal choice of a_t^* by households determines the aggregate supply of deposits $D_t^s\left(r_{m,t+1}^D; x_t^*\right) = \int_0^1 a_t^* di = a_t^*$, which depends on the optimal choice of the bank with regard to the interest rate and the portfolio composition. The optimal choice of the deposit interest rate $r_{m,t+1}^D$ by the bank and the choice of the portfolio composition x_t^* determine its demand for deposits $D_t^d\left(r_{m,t+1}^D; x_t^*\right)$. If demand D_t^d and supply D_t^s in period t are equal, one obtains the equilibrium in the market for deposits. Due to the absolute price-elasticity of the supply of risky assets (contracts providing access to the risky technology), the equilibrium investment of funds in the risky technology is given by $X_t^* = x_t^* D_t^d\left(r_{m,t+1}^D; x_t^*\right)$.

Recall that because of notational reasons, the equilibrium interest rate $r_{m,t+1}^D$ has the time-index referring to period $t+1$. However, this interest rate is set and announced in the period t so that the equilibrium is purely temporary and describes only period t.

Similarly to Proposition 2.2 from the previous chapter, the optimal choice of the monopolistic bank $\left(x_t^*, D_t^d, r_{m,t+1}^D\right)$ is $x_t^* = 1$ and the bank sets the interest rate at the lowest possible level which still guarantees the unit deposit supply from the side of consumers. According to Proposition **??**, this interest rate is given by

$$r_{m,t+1}^D = r^F + \frac{(1-p)(1-z)}{p + z(1-p)}\left(r^F - r^L\right)$$

To find the equilibrium, we just need to establish the equilibrium allocations.

Proposition 3.2 *If the regulator commits to bail out the bank with the probability z, the monopolistic equilibrium in the model is unique for each period t and given by*

$$\left\{ \begin{array}{c} X_t^* = 1 \\ D_t^* = 1 \\ r_{m,t+1}^D = r^F + \frac{(1-p)(1-z)}{p+z(1-p)}\left(r^F - r^L\right) \end{array} \right\} \tag{3.12}$$

The only difference between Proposition 2.3 and Proposition **??** is the deposit interest rate set by the bank. Since depositors do not internalize the costs of bailouts, they deposit under a lower interest rate than in Proposition 2.3. Since it was assumed that the depositors are shareholders of the bank, they obtain the monopolistic rent through dividends, and their total expected wealth is unchanged compared to Proposition 2.3. However, if only a part of depositors are shareholders of the bank, then the distortion of wealth is more severe in the case with bailouts than in the commitment-to-liquidation case, since the monopolistic rent under bailouts is higher.

3.6.4 Competitive Equilibrium

If the banking system is competitive, each individual bank is a price-taker. This changes the control variables in the optimization problem of the bank:

$$\begin{aligned} \Pi^e_{t+1} \quad &\rightarrow \quad \max_{x_t, D_t} \\ \text{s.t.} \quad &\quad 0 \leq x_t \leq 1 \\ &\quad 0 \leq D_t \end{aligned} \tag{3.13}$$

The solution to this optimization problem determines the each competitive bank's demand for deposits and its portfolio composition. Since the objective function of the bank (**??**) is the same as in the commitment-to-liquidation case, the optimal choice $\left(x_t^*, D_t^d\right)$ of the competitive bank in period t is given by Proposition 2.4 from the previous chapter:

$$D_t^*\left(r^D_{t+1}\right) \in \begin{cases} [0,\infty) & \text{if } r^D_{t+1} \geq r^H \\ \{\infty\} & \text{if } r^D_{t+1} < r^H \end{cases} \tag{3.14}$$

$$x_t^*\left(r^D_{t+1}\right) \in \begin{cases} [0;1] & \text{if } r^D_{t+1} \geq r^H \\ \{1\} & \text{if } r^D_{t+1} < r^H \end{cases} \tag{3.15}$$

Similarly to the temporary monopolistic equilibrium, one can define the temporary competitive equilibrium in a following way:

Definition 3.3 Temporary monopolistic equilibrium in period t under parameters $\left(p; r^F; r^H; r^L\right)$ is the allocation-price tuple $\left(X_t^*, D_t^*, r^D_{c,t+1}\right)$, which provides

(1) $X_t^* = x_t^* D_t^d\left(r^D_{c,t+1}\right)$ with $(x_t^*; D_t^d) \in \arg\max \Pi_t^e$

(2) $D_t^s(r^D_{c,t+1}; x_t^*) = a_t^* \in \arg\max G_t^e$

(3) $D_t^* = D_t^d\left(r^D_{c,t+1}\right) = D_t^s\left(r^D_{c,t+1}; x_t^*\right)$

In equilibrium in period t, the competitive interest rate on deposits $r^D_{c,t+1}$ is settled at the level, which equilibrates demand $D_t^d\left(r^D_{c,t+1}\right)$ and supply $D_t^s\left(r^D_{c,t+1}; x_t^*\right)$ of deposits given the optimal decision of the banks with regard to their portfolio composition x_t^*. This determines the equilibrium investment in the risky technology X_t^*.

Analogous to Proposition 2.5, one obtains that if the banks do not internalize the costs of bailout, the temporary equilibrium in competitive banking sector is the same as in the commitment-to-liquidation case.

Proposition 3.3 *If the regulator commits to bail out the banks with the probability z, there exist multiple competitive equilibria in each period t given by:*

$$\left\{ \begin{array}{c} X_t^* \in [0;1] \\ D_t^* = 1 \\ r_{c,t+1}^D \geq r^H \end{array} \right\} \tag{3.16}$$

Again, if the banks compete à la Bertrand, the deposit interest rate would be exactly $r_{c,t+1}^D = r^H$, which still does not prevent the multiplicity of the equilibria. Since the objective function of the banks under this deposit interest rate is zero, they are ambiguous in their investment decision.

In general, if the banks do not internalize the costs of bailout, the results are the same as in the commitment-to-liquidation case and the same discussion applies here. This justifies the general critique of the bailout policy as propagating moral hazard in banking. Though there is no explicit moral hazard in my model, it still demonstrates that competitive banks set the deposit interest rate higher than the expected rate of return from investment in the risky technology.

In the previous chapter, I have shown that a stochastic bailout rule (uncertain but not completely ambiguous bailouts) may be a solution to the problem of encouraging the intermediation to provide the link between the creditors and the borrowers and discouraging intermediation from setting excessively high deposit interest rate (or, in general, from excessive risk-taking, if the moral hazard explicitly modeled). This is possible through the internalization of bailout costs by banks. As the case above demonstrates, as soon as the banks do not internalize the costs of bailouts, the probabilistic (stochastic) bailout rule cannot solve the dilemma. Furthermore, if only a part of depositors are shareholders of the banks, it may even worsen the situation, since it may then lead to wealth distortions through increased monopolistic rent.

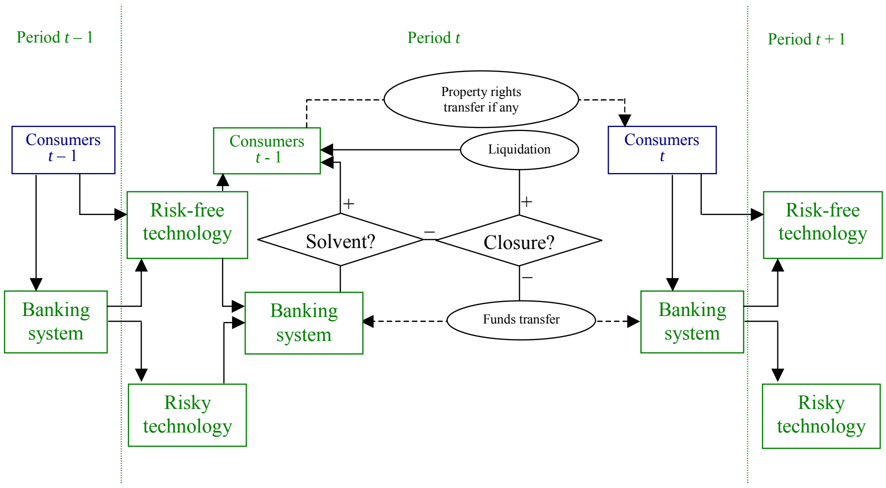

Figure 3.5. Sequence of events in the intermediated economy: regulatory forbearance

Corollary 3.2 *An uncertain (stochastic) bailout rule may have the same effect as the commitment of the regulator to liquidation of insolvent banks, if the banks do not internalize the costs of bailouts. In the case of a monopoly, bailouts may increase the monopolistic rent compared to the case of regulatory commitment to liquidation.*

3.7 Intermediated Economy: Regulatory Forbearance

Regulatory forbearance is a delay in the liquidation of an insolvent bank. In contrast to bailouts, forbearance does not require the action of the regulator to be financed through the taxes or in some other way, as is the case if the bailed out banks are subsidized. If the regulator does not liquidate an insolvent bank, it is still possible that the bank obtains enough deposits from the new generation to repay the depositors of the previous one.

The sequence of events in case of forbearance is shown in Figure **??**. The main difference between figures **??** and **??** is that the regulator does not decide whether to baioult or to liquidate, but rather decides whether to delay the liquidation in hope for a turnaround. If the regulator forbears, a transfer of funds between the new generation and the old generation is possible through the banking system. Previously, such a transfer was only possible in the form of a subsidy financed through taxes from the young generation and paid to the banking system in order to enable it to repay the deposits to the old generation. Now these are the deposits of the young generation, which may be used by the banking system to repay the old depositors. In the timing of events, first, the new deposits are collected, and only then are the old depositors repaid. The intergenerational transfer of funds is shown by the dashed arrow between the banking system belonging to the new generation and the banking system belonging to the old generation in Figure **??**. Note that if the rhombus "Closure?" is switched to "+", this transfer of funds is interrupted, since the oval "Funds transfer" is switched off. In this case, the banking system which belonged to generation $t-1$ is liquidated, no property rights are transferred to generation t, and the new banking system is created.

Effectively, forbearance implies a bailout of the banks, however not by the regulator, but rather by the future generation. These are exactly the workout incentives, which I discussed in the beginning of this chapter.

3.7.1 Supply of Deposits

The consumers of each generation are informed that the regulator can delay the bankruptcy procedure with the probability z. For depositors this means that their bank continues its operations, and would repay deposits in full at the expense of the future generation. The regulatory forbearance effectively induces implicit guarantees on the deposits, and hence the decision-making by the depositors of any generation t is the same as above (see Fig. **??**).

This results in the same deposit supply function as previously:

$$D_t^s\left(r_{t+1}^D, x_t\right) = \begin{cases} 1 & \text{if} \quad r_{t+1}^D \geq r^F + \frac{(1-p)(1-z)}{p+z(1-p)} x_t \left(r^F - r^L\right) \\ 0 & \text{if} \quad r_{t+1}^D < r^F + \frac{(1-p)(1-z)}{p+z(1-p)} x_t \left(r^F - r^L\right) \end{cases} \tag{3.17}$$

Note that now z denotes the probability of the regulatory forbearance.

3.7.2 Objective Function of the Banks

If an insolvent bank is not liquidated, the probability of which is z, the bank continues its operations and starts the next period with losses inherited from the previous one. If, however, the bank is liquidated, the probability of which is $(1-z)$, then the principle of limited liability holds. An important issue is whether the bank takes the future losses into account in its objective function. Formally, since the shareholders of the bank transfer the property rights after their deposits are repaid, they do not face losses. If the bank only maximized the profit of its current shareholders, it should again count on the limited liability

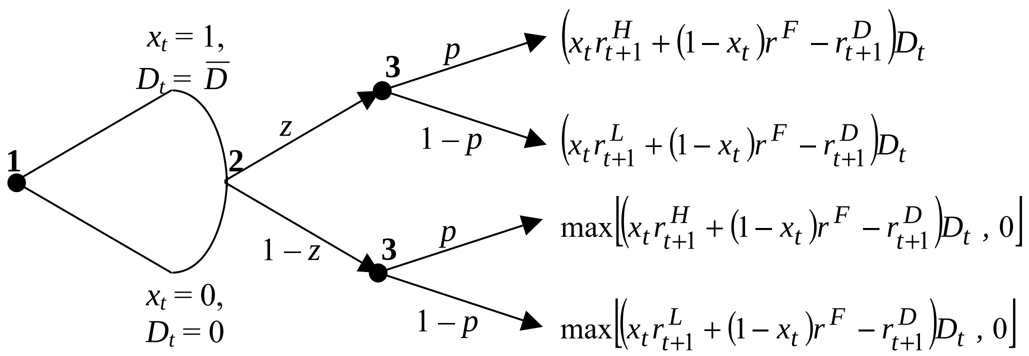

Figure 3.6. Decision-making by banks: regulatory forbearance

and no internalization of bailout-liquidation costs occurs. However, the bank continues with the new generation of shareholders, which is worse off if the losses occur. If the management of the bank (which I referred to as "bankers" in Chapter 2) is concerned with the wealth of both generations of the shareholders, it should take the future losses into consideration when determining the optimal strategy of the bank.[33]

Does the bank concern itself with the wealth of further future generations? In my model it has been always assumed that all agents and the banks make decisions over one period. This implies that the bank's target is its expected profit in the subsequent period, and not the whole flow of future profits. The decision-making of the bank over one period is presented in Figure **??**. The same notation is used as in Figure **??**.

To summarize, in each period, the bank maximizes it's expected profit of the next period and internalizes the costs of bailout. The bailout is seen as a workout by the next generation of depositors, who provide the bank with the funds needed to cover the bank's obligations before the previous generation of depositors. The internalization implies that the principle of the limited liability is not valid for the bank, if the regulator forbears and lets the bank to continue its operations. Therefore, if the bank is not closed, it may experience losses, which

[33] This effect could become more clear if one considers long lived agents, who make myopic decisions. Then the "new generation" of shareholders is effectively the same group of shareholders as before. The usage of the term "generation" is then justified only with the necessity to distinguish between the decisions made by the same agents in different periods. In such a case, it would be obvious that the bank does not count on the limited liability in case of forbearance, since its losses obviously make its shareholders worse off. An alternative way could also be an inroduction of agents, who live over three periods. Then there always exists a part of the bank's shareholders, who suffer from losses, so that the bank has to internalize the losses. I prefer to stay within a single framework throughout the entire chapter, and do not alter the model.

is a consequence of unlimited liability.

Now, the objective function of the bank in each period t takes into account the possibility of forbearance in the period $t+1$:

$$\begin{aligned}\Pi^e_{t+1} &= z\left[x_t\left(pr^H+(1-p)\,r^L\right)+(1-x_t)\,r^F-r^D_{t+1}\right]D_t+ \\ &\quad (1-z)\,p\max\left[x_tr^H+(1-x_t)\,r^F-r^D_{t+1};0\right]D_t+ \\ &\quad (1-z)\,(1-p)\max\left[\left(x_tr^L+(1-x_t)\,r^F-r^D_{t+1}\right);0\right]D_t\end{aligned} \tag{3.18}$$

To complete the analysis, one only needs to consider the decision-making by a monopolist and a competitive bank once again and find the respective equilibria.

3.7.3 Monopolistic Equilibrium

Once again, the monopoist bank maximizes its objective function Π^e_t as given by (**??**) and chooses the portfolio composition x_t, optimal amount of deposits D_t and the deposit interest rate r^D_{t+1}:

$$\begin{aligned}\Pi^e_{t+1} &\rightarrow \max_{x_t,D_t,r^D_t} \\ \text{s.t.} &\quad 0\le x_t\le 1 \\ &\quad 0\le D_t\le D^s_t\left(r^D_{t+1},x_t\right)\end{aligned} \tag{3.19}$$

Since it is optimal for the monopolist bank to set the deposit interest rate at the lowest level which still guarantees the unit amount of deposits, one can expect that the result for monopolist bank would be the same as in the prioviously considered case of bailouts. We only need to check whether the objective function of the bank is still non-negative under $r^D_{m,t+1}=r^F+\frac{(1-p)(1-z)}{p+z(1-p)}\left(r^F-r^L\right)$ and with the supply of deposits given by (**??**).

Proposition 3.4 *If the regulator pursues forbearance in period $t+1$ with probability z, the optimal choice of the monopolist bank in period t is*

$$\begin{aligned}x^*_t &= 1 \\ D^d_t &= 1 \\ r^D_{m,t+1} &= r^F+\frac{(1-p)\,(1-z)}{p+z\,(1-p)}\left(r^F-r^L\right)\end{aligned}$$

Note that in contrast to Proposition 2.10, which was based on effectively the same objective function of the bank, we now obtain determinacy in the choice of the bank. This is due to the new deposit supply function, which exhibits less cautionary behaviour of depositors. Hence, the bank has the possibility of setting a lower deposit interest rate than in Proposition 2.10, and this guarantees positive objective function.

Since the optimal choice of the monopolist bank equates the supply of deposits and the demand for them, the following proposition is obvious.

Proposition 3.5 *If the regulator pursues forbearance in a period $t+1$ with probability z, then the temporary monopolistic equilibrium in the period t is*

$$\left\{ \begin{array}{c} X_t^* = 1 \\ D_t^* = 1 \\ r_{m,t+1}^D = r^F + \frac{(1-p)(1-z)}{p+z(1-p)} \left(r^F - r^L \right) \end{array} \right\} \tag{3.20}$$

With $z = 0$, we obtain the case of commitment to liquidation as in Proposition 2.3 in the previous chapter. With $z = 1$, the monopolist bank then sets interest rate at $r_{m,t+1}^D = r^F$, and the probability of deposit being paid in full is $\rho^* = 1$. This differs significantly from the cases discussed in Chapter 2, in which the depositors internalized the costs of bailout and exhibited caution in their decision-making. Instead, in the current chapter, the depositors do not internalize the costs of bailouts or liquidation, and this explains the difference in results.

3.7.4 Competitive Equilibrium

Assume there exists in each period t a continuum of competitive banks distributed at the unit interrval, who are price-takers in the deposit market. Each competitive bank maximizes its objective function (**??**):

$$\begin{aligned} \Pi_{t+1}^e \quad &\rightarrow \quad \max_{x_t, D_t} \\ \text{s.t.} \quad &\quad 0 \leq x_t \leq 1 \\ &\quad 0 \leq D_t \end{aligned} \tag{3.21}$$

Since the objective function of the banks repeats their objective function in case of uncertain bailouts and internalization of bailout costs (Chapter 2, Section 2.5), we can use the result of Proposition 2.12:

Proposition 3.6 *If the regulator pursues forbearance in a period $t+1$ with probability z,* *the optimal choice* $\left(x_t^*, D_t^d\right)$ *of a competitive bank in the period* t *is given by:*

$$x_t^* \in \begin{cases} [0;1] & \text{if } r_{t+1}^D \geq \frac{1}{p+z(1-p)}\left(pr^H + z(1-p)r^L\right) \\ \{1\} & \text{if } r_{t+1}^D < \frac{1}{p+z(1-p)}\left(pr^H + z(1-p)r^L\right) \end{cases}$$

$$D_t^d \in \begin{cases} \{0\} & \text{if } r_{t+1}^D > \frac{1}{p+z(1-p)}\left(pr^H + z(1-p)r^L\right) \\ [0,\infty) & \text{if } r_{t+1}^D = \frac{1}{p+z(1-p)}\left(pr^H + z(1-p)r^L\right) \\ \{\infty\} & \text{if } r_{t+1}^D < \frac{1}{p+z(1-p)}\left(pr^H + z(1-p)r^L\right) \end{cases}$$

To determine the competitive equilibrium in a period t in line with definition **??**, we again need to satisfy the condition $D^d = D^s$. Although the choice of the competitive bank coincides with the one given by Proposition 2.12, the equilibrium differs now from that in Proposition 2.13 since depositors do not internalize the costs of bailouts.

Proposition 3.7 *If the regulator pursues forbearance in a period* $t+1$ *with probability* $z \in (0,1]$*, the temporary competitive equilibrium in the period* t *is:*

$$\left\{ \begin{array}{c} X_t^* = 1 \\ D_t^* = 1 \\ r_{c,t+1}^D = \frac{1}{p+z(1-p)}\left(pr^H + z(1-p)r^L\right) \end{array} \right\} \tag{3.22}$$

Note again that as z approaches 0, this equilibrium is very similar to the competitive equilibrium under limited liability (commitment to liquidation). With $z = 0$ we obtain the case, in which the regulator commits to the liquidation of insolvent banks, and banks do not internalize the bilout-liquidation costs. With $z \to 0$, the competitive equilibrium is unique and is characterized by the interest rate $r_c^D \to r^H$. The intuition behind this is that with even a very small probability of the bailout, the banks still (partially) internalize the costs of insolvency, and this prevents deposit interest rate from being excessively high.

If $z = 1$, the competitive banking sector offers deposit interest rate exactly at the level of expected rate of return of the risky asset. This corresponds to the case of bailouts, but remember that in case of forbearance, bailouts are not performed by the regulator, but are implemented through the workout incentives of the future generations.

Corollary 3.3 *Regulatory forbearance may have a positive effect if the workout incentives of future generations ensure full repayment on the deposits of the current generation of depositors. This positive effect has two dimensions: first, it is the allocational efficiency, and second, it is the prevention of excessively high interest rates in the competitive banking sector. It is important that under forbearance banks internalize bailout costs, otherwise the positive effect may disappear.*

3.8 Ambiguity, Beliefs and Forbearance: Implications of the Dynamic Setting

In Chapter 2, I considered ambiguity with regard to the bailout policy of the regulator. In the static setting of Chapter 2, it is possible that such ambiguity induces assymmetry in the beliefs of depositors and bankers with regard to the insolvency resolution. In a dynamic setting, beliefs may be updated from period to period. One can expect that the updating process converges to some probabilistic rule, even if the regulator does not follow any. In this case, the asymmetry in beliefs can disappear, and both depositors and bankers would believe that liquidation will be performed with some probability $(1 - z)$, which can be understood as the ratio of average number of liquidations to the average number of insolvencies per period over a sufficient number of periods.

However, if the probability of liquidation $(1 - z)$ is known, it is not clear, what happens in "no liquidation" case. The analysis in this chapter shows that there is a difference between the case in which an insolvent bank is bailed out at the expense of future generations, or when it is allowed to continue in a hope of a turnaround (regulatory forbearance). In both cases, depositors are repaid in full, but the decision-making by banks is different, and may again lead to inefficient intermediation if the banks do not internalize the insolvency costs. This argument stresses that the policy of "constructive ambiguity" cannot be completely ambiguos and some signal to banks regarding the insolvency resolution procedure is desired.

Another issue is whether the beliefs of bankers and depositors converge to the same probabilistic rule? If they follow the same updating process then the answer is "yes". However it is unclear whether the beliefs of depositors and bankers follow the same updating process. This is especially unclear if one recalls that a signal from the regulator to banks regarding the insolvency resolution procedure is desired. In such a case, we obtain asymmetry in beliefs combined with the asymmetry in information, and it is hard to imagine that there exists some updating rule which would help depositors to reveal the true information from the past observations.

So was Bagehot right after all, when he argued that the regulator should follow a precise bailout-liquidation rule?[34] The answer to this question depends on the way one understands

[34] "Was Bagehot right after all?" is the second title of the paper by Rochet and Vives (2002) and refers to Bagehot's

the "preciseness" of the bailout rule. Both commitment to liquidation and commitment to bailouts may be harmful for the economy, if the banks do not internalize the costs of bailouts. This could be an argument in favour of constructive ambiguity. At the same time, the regulator can "play a mixed strategy" and commit to a stochastic (probabilistic) bailout rule. Such commitment may be interpreted as the constructive ambiguity, and hence adherents of the Bagehot's rule and proponents of the constructive ambiguity do not necessarily contradict each other. Moreover, if the regulator commits to a stochastic bailout rule, the probability of liquidations may become known to the public within several periods through the updating of beliefs, so that there is no need to explicitly communicate the rule to the public.

Remember that constructive ambiguity was defined "with regard to how, when and whether" the banks are bailed out. The analysis in Chapters 2 and 3 shows that a crucial difference may appear between these cases that differ in "how" and "when". It is important that the way bailouts are performed induces internalization of the bailout costs by the banks. If this is ensured, then the difference between the regulatory bailouts and the bailouts through the next generations under regulatory forbearance disappears. In such a case, it may be important to keep ambiguity with regard to the timing of the regulatory bailout: if depositors are sure the regulator can always obtain funds from the future generations to save the banks, then the cautionary decision-making by depositors disappears, and this contributes to the efficiency of the intermediation. This effect is similar to the deposit insurance in the model of Diamond and Dybvig (1983), in which, in order to coordinate the agents on the "good" equilibrium, it suffices to introduce the state guarantee on deposits, but there will be no need to exersise this guarantee since no failures would happen. As Schwartz (1986) writes, "knowledge of the availability of credit is sufficient to allay alarm". I will use this result in the next chapter to construct a dynamic model, in which regulatory guarantees suffice to ensure the inflow of new deposits into the banking system in each period. Such workout incentives should provide for the soundness of financial intermediation and for the efficiency of resulting equilibrium allocation of funds.

In the previous text, I focused on the allocation of funds in the temporary equilibrium. The objective of the analysis was to reveal the conditions under which the intermediated economy

(1873) suggestion that a bailout-liquidation policy of the regulator should follow a precise rule.

ensures that the whole endowment of the depositors is invested in the risky technology (risky financial asset). Intertemporal effects have not been considered.

Remember that there is a difference between the activities of the banks in the static and in the dynamic settings. In the two-period model, actions of the banks in the two subsequent periods are distinct: first, the banks collect deposits from households and invest them into the risky investment project, and second, in the subsequent period, the banks realize gains from their financial portfolio and are either liquidated due to insolvency, or duely closed in the end of economy after having repaid their debts in full. In the dynamic setting, under forbearance, the actions of banks in two distinct periods are the same: they realize gains from their portfolio, and if not liquidated due to insolvency, repay debts to depositors of the previous period and simultaneously collect new deposits to be invested in the risky production technology. Since the banks repay old deposits and collect new deposits within one period, this provides them with an opportunity to stay liquid even if insolvent: if an insufficient repayment from the production technology, which is shared with entrepreneurs, does not allow them to repay the deposits from the previous period in full, the banks can use the funds from newly collected deposits to cover the deficit. For an arbitrary period t, as soon as the state of nature $\mathbf{s}_t \in \{H, L\}$ is realized, we can denote the difference between the gains from investment and the deposit repayment due in that period with $d_t^{\mathbf{s}_t}$:

$$d_t^{\mathbf{s}_t} = (1 + r^{\mathbf{s}_t})\, D_{t-1} - \left(1 + r_t^D\right) D_{t-1}$$

Here, D_{t-1} is the amount of deposits in the banking system in period $t-1$, which are repaid with the interest rate r_t^D. Note that the deficit $d_t^{\mathbf{s}_t}$ is state-contingent as well as is the rate of return of the production technology $r^{\mathbf{s}_t}$.

In period t, the banks collect new deposits and have to account for the deficits $d_t^{\mathbf{s}_t}$ in their objective function, which results in the change in their deposit demand, and hence in the deposit interest rate. This demonstrates that the equilibrium interest rates studied previously in this chapter are time-independend only if one considers the decision-making of a solvent bank, with zero deficits. I examine the role of the deficits in Chapters 4 and 5 in a general equilibrium context.

3.9 Summary

An uncertain (probabilistic) bailout rule does not necessarily lead to the internalization of the bailout costs by banks. An example of this is the case in which the bailouts are financed by future generations so that if banks maximize the gains of their current depositors, the costs of the bailout are not taken into account. In this case, intermediation may be inefficient. On the one hand, this stresses the need for a design of the bailout policy which would provide for the internalization of insolvency costs by banks.

On the other hand, as shown in Chapter 2, it is desirable that the depositors do not internalize the costs of bailouts, otherwise they exhibit cautionary behaviour, which may lead to inefficient intermediation or to disintermediation. Workout incentives of the future generations provide a convenient tool to make depositors less cautionary in their choice.

Uncertainty with respect to bailout policy is one of the pillars of the constructive ambiguity. Another pillar is uncertainty in the timing of bailouts, which leads to the regulatory forbearance. Regulatory forbearance may help to achieve the efficiency of financial intermediation, but only if there exist intergenerational workout incentives, which ensure the inflow of deposits into the banking system in each period. Forbearance induces internalization of losses by banks, and intergenerational workout incentives eliminate internalization of bailout costs by the depositors. Under such conditions, uncertainty with regard to the timing of bailout may promote the efficiency of financial intermediation.

However, allocative efficiency within one period does not necessarily imply allocative efficiency intertemporally. Since the banks may be allowed to continue their operations in case of insolvency, they may experience deficits which arise through repaying depositors in full under insufficient return from investment. These deficits should be covered through newly acquired deposits, and influence the demand of banks for deposits. As a result, the equilibrium deposit interest rate may non-trivially change from period to period, depending on the actual realizations of the state contingent return on the risky technology.

In the next chapters, I present a general equilibrium model, suitable for examining such intertemporal effects. I relax some assumptions made in the current chapter and in the previous one. First, up to this point it has been assumed that the depositors decide upon one fixed unit of investment; I relax this assumption and introduce intertemporal decision-making of the agents with regard to savings and consumption. Secondly, it has been assumed that the entrepreneurs grant access to the production technology for free; I relax this assumption and introduce decision-making by entrepreneurs with regard to the optimal amount of investment. Thirdly, the credit market has been modelled implicitly; in the next chapter, I introduce an explicit credit market along with the market for work.

I use the same comparison framework as in this chapter, namely I compare the intermediated economy with a market one in order to trace out the possible inefficiencies of the intermediation. In Chapter 4, I consider a general equilibrium model without uncertainty, which would correspond to a (very simplified) case $r^H = r^F = r^L$ with probability $p = 1$ in terms of the notation above, and I will show that the market-based and bank-based financial systems are statically and dynamically equivalent under these conditions. In Chapter 5, I introduce a disturbance in form of an effectively unanticipated macroeconomic shock, which could be seen as an implementation of a special case $r^H = r^F > r^L$ with probability $p = 1 - \varepsilon$, $\varepsilon \to 0$. Effectively, this will not create any uncertainty in decision-making, but will result in a different evolution of the market economy and the bank-based one. This will stress the role of the bailout policy and of the complementary policy tools even in the world with no risk.[35]

[35] There is still a Knightian uncertainty in the model, since a shock happens with a positive probability. This (objective) probability is, however, close to zero, and the agents cannot account for a possibility of shock, hence there is no risk (defined by Knight, 1921, as a measurable uncertainty). In contrast, there is no Arrowian uncertainty, which is defined from the point of view of the agents, who use their beliefs and assign subjective probabilities to events in order to assess their possibility. (Arrow, 1963, 1971)

Appendix 3.A

Proofs

Proof of Lemma **??**

Proof.

The proof is similar to the Lemmas in the previous Chapter.

■

Proof of Proposition **??**

Proof.

The proof repeats the proof of Proposition 2.1.

■

Proof of Proposition **??**

Proof.

To prove the proposition it suffices to consider 3 cases $\widetilde{r}^H_{t+1} < r^D_{t+1}$, $\widetilde{r}^L_{t+1} < r^D_{t+1} \leq \widetilde{r}^H_{t+1}$ and $r^D_{t+1} \leq \widetilde{r}^L_{t+1}$ and to find a solution of the profit maximization problem in each case. Obviously, the case $\widetilde{r}^H_{t+1} \leq r^D_{t+1}$ leads to a negative objective function of the bank and to the consequent choice of $x^*_t = 0$ and $r^D_{m,t+1} = r^F$ in order to eliminate losses. Both cases $\widetilde{r}^L_{t+1} < r^D_{t+1} \leq \widetilde{r}^H_{t+1}$ and $r^D_{t+1} \leq \widetilde{r}^L_{t+1}$ lead to the choice of $x^* = 1$, but if $r^D_{t+1} \leq \widetilde{r}^L_{t+1}$ then we obtain a zero objective function due to the zero deposit supply. It is easy to check that the solution in the interval $\widetilde{r}^L_{t+1} < r^D_{t+1} \leq \widetilde{r}^H_{t+1}$ provides for a positive objective function of the bank.

■

Proof of Proposition **??**

Proof.

Comparing equations for deposit demand (**??**) and deposit supply (**??**) we obtain that the only possibility for equilibrium is $r^D_{c,t+1} = \frac{1}{p+z(1-p)}\left(pr^H + z\left(1-p\right)r^L\right)$. A higher deposit interest rate generates excessive supply (under zero deposit demand according to equation

??). A lower interest rate generates excessive (infinitely high) deposit demand. We need only to check, that the deposit supply is positive under $r^D_{c,t+1}$ above. This is guaranteed by the assumption **??**.

■

Chapter 4
Markets versus Financial Intermediation: Dynamic General Equilibrium Analysis

In this chapter, I introduce an overlapping generations model with two types of agents and two production factors. I consider several definitions of the general equilibrium and compare them with those used in the literature. I also provide a comparison of my model with benchmark models. The discussion of the existence and of the uniqueness of the equilibrium allows comparison of the market and the intermediated economy in a static context. The existence and the uniqueness of the steady state (stationary point) allow one to come to a conclusion, under which conditions the market economy and the intermediated one are dynamically equivalent to each other.

4.1 Financial Intermediation in the Macroeconomic Context

There has been a rapid growth in the financial intermediation literature since Gurley and Shaw (1960). One of the most complete recent reviews in financial intermediation theory is the one by Gorton and Winton (2003). I reviewed the main strands in the literature in Chapter 1 of this dissertation. It can be argued that financial intermediaries, defined as firms that borrow from consumers/savers and lend to firms that need resources for investment, and are mostly referred to as banks, are promoters of economic efficiency. This role of intermediaries is performed *inter alia* through monetary channeling, transaction costs and risk reduction, as well as information provision.

A special interest in financial intermediation arose in 80-90's years of the last century due to a chain of financial distortions and crises. Financial intermediation is called one of the possible reasons for these disturbances. An analysis of sources of financial crises can be found, for example, in Mishkin (2001) and Sachs (1998). Sachs distinguishes between four triggering mechanisms of financial, exchange and banking crises: exogenous shock, policy shock, exhaustion of borrowing limits and a self-fulfilling panics. I focus here on banking crises, i.e. the crises in the sphere of financial intermediation, separating them from other types of crises, although this distinction is not always easily made in reality.

A self-fulfilling banking panic is the most familiar among these triggering mechanisms (see e.g. Diamond and Dybvig, 1983, and innumerous further contributions to this topic). The focus of my research in this and the subsequent chapter is the study of a shock-driven banking crisis and its possible relation to the exhaustion of borrowing resources.

This short introduction does not aim to discuss all possible ways of studying crises mechanisms and preventive measures. Some reviews of the theoretical proceedings in the field of banking regulation, dedicated to avoid crises and/or minimize their economic consequences can be found in Dewatripont and Tirole (1994) and Bhattacharia, Boot and Thakor (1998). However, empirical findings show that theoretically optimal regulation does not necessarily lead to avoidance of distortions. For example, Demirgüc-Kunt and Detragiache (2000) question whether deposit insurance increases banking system stability; Barth, Caprio and Levine (2000) raise the same question with respect to regulation and ownership. Further empirical evidence on bank insolvencies and crises can be found in Caprio and Klingebiel (1996) or Arteta and Eichengreen (2000). These findings show that there is a need for a solid macroeconomic theory of financial intermediation in order to create the possibility of studying the problem in its complexity beyond the framework that is normally imposed in microeconomic theory of banking.

Bernanke and Gertler (1987) embed the banking sector into a stylized general equilibrium framework to show that banks matter to real activity mainly because they provide the only available conduit between savers and investment projects, which require intensive evaluation and auditing. They also show the usefulness of such models for understanding financial crises, disintermediation, banking regulation and certain types of monetary policy. Another general equilibrium model with financial intermediation in a static form is presented by Bencivenga and Smith (1991), who suggest a simple theoretical framework for studying various financial regulations of the financial system in the context of macroeconomic growth.

In Chapter 3, I suggested a possible extension of a partial equilibrium analysis to yield a macroeconomic interpretation of the partial equilibrium results. This interpretation mainly concerns the treatment of the risky asset as a risky production technology. In this context, the only macroeconomic effect of the intermediation could be found in the equilibrium allocation of resources. As the analysis in Chapters 2 and 3 suggests, some regimes of the bailout policy may lead to an inefficient allocation of resources as compared to the allocation achieved in a market economy. In order to promote efficiency, the bailout policy should induce the internalization of the bailout costs by banks and at the same time reduce the internalization of these costs by depositors. Other macroeconomic effects regarding intermediation were not considered in Chapters 2 and 3.

In the current chapter, I further develop the model to make it suitable for the study of the effects of the intermediation on goods and labor markets. I depart from the dynamic model of Chapter 3 and extend it in the direction of the analysis of Gersbach and Wenzelburger (2002, a and b). To model the goods market, I replace the constant return to scale one-factor risky production technology with a decreasing return to scale two-factors production technology. This eliminates the risk in the model and allows one to focus on the dynamic effects of the intermediation on the markets for both production factors as well as on the aggregate output in the economy. Instead of periodical stochastic disturbances, I will consider a sudden macroeconomic shock in the next chapter, which will allow one to illuminate the differences between the market economy and the intermediated one in processing the shock.

I also replace the assumption of a unit goods endowment of the population with an assumption of the unit labor endowment, which allows one to model the labor market. This is one of the principal differences between my model and that of Gersbach and Wenzelburger (2002 a and b). Further changes in assumptions with regard to the macroeconomic environment are minor and concern only the size of the population and their consumption plans.

The intermediation is present through a competitive banking system. I assume banks to be allowed to continue to operate even in case of their insolvency. As the analysis in the previous chapters show, this may be viewed as the regulatory forbearance or as a bailout scheme through which banks internalize the costs of bailout, but each current generation of depositors does not. In the current chapter, risk is eliminated from the model. Hence an insolvency of banks cannot occur and the choice of the insolvency resolution procedure is irrelevant. In Chapter 5, I introduce risk in the form of an unanticipated shock, which makes the insolvency resolution relevant. However, since the shock is unanticipated, it is convenient to assume that the regulator allows the insolvent banks to continue to operate in hope for a turnaround. It is important that depositors do not internalize the costs of the banks' failure.

As a dynamic structure, I use the overlapping generations setting. The question of the equivalence between long-term oriented Overlapping Generations (OLG) and short-term oriented Infinitely Lived Representative Agent (ILRA) models is not discussed here, although it can be expected that the results obtained for a simplified OLG will also be valid for quickly developing short-term processes, for example, under the assumption of the myopia in the agents behavior. Some discussion on both approaches and on the similarity of their results can be found, for example, in Lovo (2000), Aiyagari (1987 and 1992), Huo (1987) and Woodford (1986) so that I do not further focus on this matter.

4.2 Basic General Equilibrium Model

In the description of the model I will follow, where possible, the notation of the Diamond's (1965) classical model. Later on, I will provide a comparison of the two models to trace out the principal differences between them. I will also provide a comparison with some other famous models.

4.2.1 Agents and Decisions

Consider an economy with a population living for two periods and divided into two groups: workers and entrepreneurs. The whole population is distributed over the interval $[0, 1]$, and the subinterval $[0, \eta)$ belongs to workers, leaving $[\eta, 1]$ for entrepreneurs, so that η is the share of workers in each generation.[36] The entrepreneurs can only run their firms

[36] I assume that the share of workers in each generation is fixed. Gersbach and Wenzelburger (2002 a and b)

as they acquire some experience in the first period of their lives. As a result, the whole generation consists only of workers when young. The young generation works, consumes and saves. The old generation consumes (if workers) or produces and consumes (if entrepreneurs). All members of each generation are endowed with one unit of labor in the first period of their lives. The entrepreneurs possess equal entrepreneurial skills, which they apply in the second period of their lives so that there is no heterogeneity among workers and among entrepreneurs.

All agents of generation $t \geq 1$ have identical intertemporal utility functions $u\left(c_t, c_{t+1}\right)$, which is continuous and satisfies following standard assumptions on monotonicity and concavity:

$$\frac{\partial u}{\partial c_t} > 0; \frac{\partial u}{\partial c_{t+1}} > 0 \tag{A-4-1}$$

$$\frac{\partial^2 u}{\partial c_t^2} < 0; \frac{\partial^2 u}{\partial c_{t+1}^2} < 0; \frac{\partial^2 u}{\partial c_t \partial c_{t+1}} > 0 \tag{A-4-2}$$

The time index denotes the beginning of the period so that generation t is born at moment t when period t begins, is young till moment $t+1$, is old in period $t+1$ and dies in moment $t+2$, which ends period $t+1$. As the agents live only for two periods, this is their life-time utility function.

The production technology available to entrepreneurs uses k units of capital and l units of labor to produce $f(k, l)$ units of the consumption good, is continuous and fulfills following assumptions:

$$\frac{\partial f}{\partial k} > 0; \frac{\partial f}{\partial l} > 0 \tag{A-4-3}$$

$$\frac{\partial^2 f}{\partial k^2} < 0; \frac{\partial^2 f}{\partial l^2} < 0 \tag{A-4-4}$$

$$f(0,0) = 0 \tag{A-4-5}$$

Finally, to exclude corner solutions of optimization problems below, I assume

$$\lim_{c_t \to 0} \frac{\frac{\partial u}{\partial c_t}}{\frac{\partial u}{\partial c_{t+1}}} = \infty; \lim_{c_{t+1} \to 0} \frac{\frac{\partial u}{\partial c_t}}{\frac{\partial u}{\partial c_{t+1}}} = 0$$

consider the case with heterogenous agents, in which the entrepreneurs with insufficiently high productivity can switch to workers. This market side switching makes the share of entrepreneurs endogenous. This will not change the results since there always exists a group of entrepreneurs with sufficiently high productivity of the production technology. The mass of this group can be taken as η.

and

$$\lim_{l\to 0}\frac{\frac{\partial f}{\partial l}}{\frac{\partial f}{\partial k}}=\infty;\ \lim_{k\to 0}\frac{\frac{\partial f}{\partial l}}{\frac{\partial f}{\partial k}}=0$$

All generations are identical, except the old generation of period $t = 1$ (born in period $t = 0$), which lives only for one period and is initially endowed with some amount of consumption good. This generation also consists of entrepreneurs and non-entrepreneurs, with the latter called "workers" for consistency in notation. The decision-making of this generation is as follows.

The "workers" can lend their initial endowment s_0^W to the entrepreneurs at the interest rate r_1, and, therefore, face a one-period utility maximization problem

$$\begin{aligned} u(c_1) &\rightarrow \max_{c_1} \\ \text{s.t. } c_1 &= (1+r_1)\, s_0^W \end{aligned} \tag{4.1}$$

The utility maximization fixes the credit supply in the amount of the initial endowment s_0^W.

The entrepreneurs are endowed with s_0^E and run their firms to extract profit $E_1 = f(k_1, l_1) - (1+r_1)\left(k_1 - s_0^E\right) - w_1 l_1$. Their utility maximization problem is

$$\begin{aligned} u(c_1) &\rightarrow \max_{c_1} \\ \text{s.t. } c_1 &= E_1\left(s_0^E, w_1, r_1\right) \end{aligned} \tag{4.2}$$

The profit maximization problem determines the demand for credit $\left(k_1 - s_0^E\right)$ and the demand for labor l_1 as functions of the interest rate r_1 and of the wage rate w_1. The credit market involves trade between old entrepreneurs and old workers of generation 0. The labor market involves trade between the old entrepreneurs and the whole young generation born in period 1.

All workers of any generation $t \geq 1$ solve, when young, an intertemporal utility maximization problem, which determines their consumption c_t and savings s_t^W in period t, as well as their consumption c_{t+1} in the period $t+1$.

The optimization problem of workers is given by[37]

$$\begin{aligned} u\left(c_t, c_{t+1}\right) &\rightarrow \max_{c_t, c_{t+1}, s_t^W} \\ \text{s.t. } c_t &= w_t - s_t^W \\ c_{t+1} &= \left(1 + r_{t+1}\right) s_t^W \end{aligned} \tag{4.3}$$

The earnings $(1 + r_{t+1}) s_t^W$ of workers of generation t in the second period of their lives arise from the savings s_t^W made in the period t and invested in the loans/credit market with the interest rate r_{t+1}, which is a rate of interest existing on one-period loans from period t to period $t+1$ (as in Diamond, 1965). This problem determines the savings function of workers

$$s_t^W = s^W \left(\underset{+}{w_t}, \underset{+}{r_{t+1}} \right)$$

Potential entrepreneurs solve their respective utility maximization problem

$$\begin{aligned} u\left(c_t, c_{t+1}\right) &\rightarrow \max_{c_t, c_{t+1}, s_t^E} \\ \text{s.t. } c_t &= w_t - s_t^E \\ c_{t+1} &= E_{t+1}^e \left(s_t^E, w_{t+1}^e, r_{t+1}\right) \end{aligned} \tag{4.4}$$

where E_{t+1}^e denotes their expected profit in the period $t+1$, when the entrepreneurs extract their earnings from running the firms; w_{t+1}^e denotes the wage expected to exist in the period $t + 1$. The entrepreneurs may choose whether they invest their savings s_t^E into their firms or act as creditors in the credit market. Formally, the budget constraint for the second period of their lives could be written as

$$c_{t+1} = \max \left[E_{t+1}^e \left(s_t^E, w_{t+1}^e, r_{t+1}\right); \left(1 + r_{t+1}\right) s_t^E \right]$$

If the entrepreneurs opt not to produce, their optimization problem is identical to that of the workers. However, this case is irrelevant for the analysis. The equilibrium outcome would guarantee that $(1 + r_{t+1}) s_t^E < E_{t+1}^e \left(s_t^E, w_{t+1}^e, r_{t+1}\right)$. Otherwise, all entrepreneurs avoid running firms and the demand for credit is zero with a positive credit supply.

Entrepreneurs run firms when old, and the production technology of these firms is given

37 Formally, a housheold is able to choose labor supply l, which would determine the labor income and change the first constraint to $c_t = l_t w_t - s_t^W$. Since each household is endowed with $\bar{l}_t = 1$, the restriction on l_t is $l_t \leq 1$. The first derivative of the utility function with respect to l_t is strictly positive as soon as $w_t > 0$, which implies the optimal choice $l_t \leq 1$. To simplify the exposition, I omit l_t in the optimization problem and only focus on savings-consumption decisions.

by $f\left(k_{t+1}, l_{t+1}\right)$, where k_{t+1} = physical capital for production in period $t+1$, and l_{t+1} = the amount of labor used for production in period $t+1$. All entrepreneurs have access to the same production technology (so that there is no heterogeneity among entrepreneurs), and maximize their expected profit, thereby defining both k_{t+1} and l_{t+1}. In period t, potential entrepreneurs apply for the credit I_t, which is needed to acquire the capital stock k_{t+1} so that $k_{t+1} = s_t^E + I_t$. Note that k_{t+1} denotes the capital acquired in the period t and used for the production in the period $t+1$, exactly as in Diamond (1965).

The expected profit of the entrepreneurs born in period t is:

$$E_{t+1}^e = f\left(k_{t+1}, l_{t+1}\right) - \left(1 + r_{t+1}\right)\left(k_{t+1} - s_t^E\right) - w_{t+1}^e l_{t+1}$$

The profit maximization problem implies

$$f\left(k_{t+1}, l_{t+1}\right) - \left(1 + r_{t+1}\right)\left(k_{t+1} - s_t^E\right) - w_{t+1}^e l_{t+1} \rightarrow \max_{k_{t+1}, l_{t+1}} \tag{4.5}$$

and the solution of this problem for any level of savings s_t^E appears as

$$k\left(r_{t+1}, w_{t+1}^e\right) : \frac{\partial k}{\partial r_{t+1}} < 0, \frac{\partial k}{\partial w_{t+1}^e} < 0 \tag{4.6}$$

$$l\left(r_{t+1}, w_{t+1}^e\right) : \frac{\partial l}{\partial r_{t+1}} < 0, \frac{\partial l}{\partial w_{t+1}^e} < 0 \tag{4.7}$$

Note that the solution of the profit maximization problem does not depend on the savings level, as established by the following

Proposition 4.1 *Decisions of the entrepreneurs on their optimal savings and optimal production plans are separated.*

This is a standard fact for two-period models, a simple proof of which is presented in Appendix **??**. The same result in known for one-factor capital-dependent production technologies as **Fisher's Separation Theorem** (see Fisher, 1930, and Hirshleifer 1958, 1970). Given this optimal choice of the production factors, the utility maximization problem of the entrepreneurs determines their savings level:

$$\begin{aligned} u\left(c_t, c_{t+1}\right) &\rightarrow \max_{c_t, c_{t+1}, s_t^E} && (4.8) \\ \text{s.t. } c_t &= w_t - s_t^E \\ c_{t+1} &= E_{t+1} = f\left(k_{t+1}, l_{t+1}\right) - \left(1 + r_{t+1}\right)\left(k_{t+1} - s_t^E\right) - w_{t+1}^e l_{t+1} \\ \text{with } \left(k_{t+1}, l_{t+1}\right) &= \arg\max E_{t+1} \end{aligned}$$

The savings of the entrepreneurs are then given by the function

$$s_t^E = s^E\left(\underset{+}{w_t}, \underset{-}{w_{t+1}^e}, \underset{+}{r_{t+1}}\right) \tag{4.9}$$

Properties of the solutions of optimization problems are taken as standard results of microeconomic analysis.[38]

4.2.2 Interactions in the Basic Model

The behavior of the old generation 0 in period $t = 1$ is described above. The following summarizes the interactions, which appear in any period $t > 1$.

In period t, the workers of generation t create their savings s_t^W. At the end of period t, entrepreneurs of generation t need to acquire an additional capital stock $I_t = k_{t+1} - s_t^E$ to start their businesses (run firms). In this basic setting, I assume there exists a credit market, in which the workers can trade their savings against promissory notes of the entrepreneurs.

Investment in the production technology takes place at the end of period t.[39] Capital payoffs from entrepreneurs to workers take place within period $t+1$ and amount to $b_{t+1} = \left(1 + r_{t+1}\right) I_t$ individually. The total payoff of all entrepreneurs to all workers within the period $t+1$ is hence $B_{t+1} = \left(1 - \eta\right) b_{t+1}$.

The sequence of events in the market economy is presented in Figure **??**.

To complete the description, one only needs to introduce expectations of generation t regarding wage rate w_{t+1}. There are two ways to do this. First, one can employ any relevant expectations rule (see Grandmont, 1977) which will allow one to study the temporary

38 To prove these properties it suffices to find respective derivatives of the implicit savings and factor demand functions, given by the first-order conditions. Corner solutions have been excluded by assumption.

39 It can also be viewed as though entrepreneurs of generation t create their production facilities along the period t, investing in amount of k_{t+1} so that the investment process ends at the end of period t. This means that all credits are allocated in the credit market in period t with the interest rate r_{t+1}.

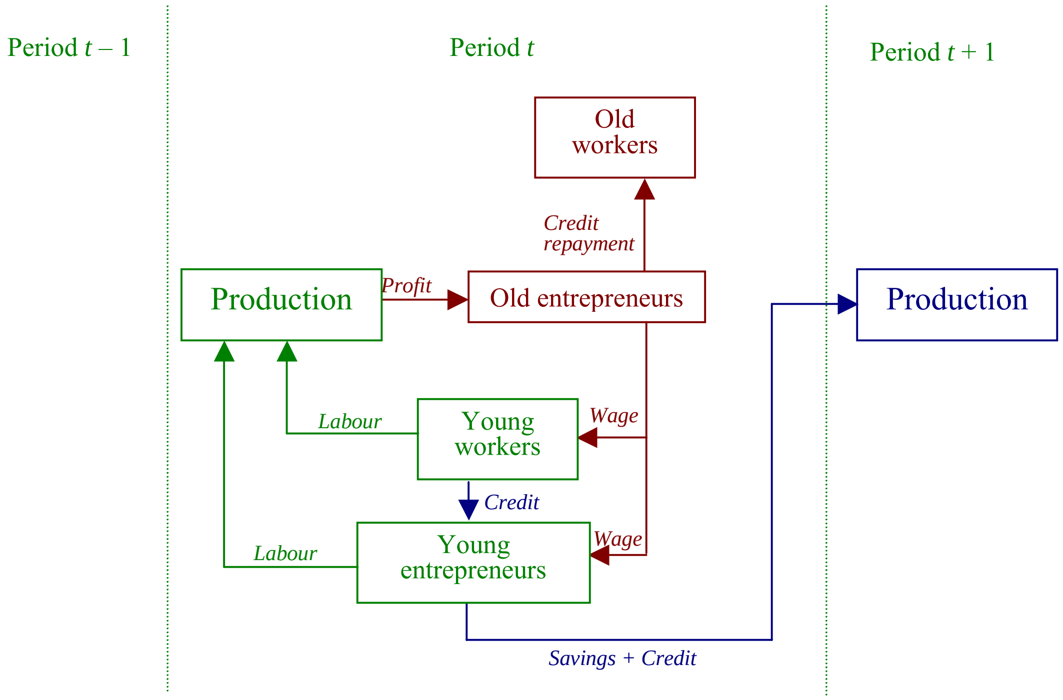

Figure 4.1. Sequence of events in the basic model

equilibria. Second, one can assume perfect foresight (as e.g. in Radner, 1972; Böhm and Puhakka, 1988), i.e. that the agents of generation t perfectly know which wage w_{t+1} will exist in the labor market in period $t+1$. This leads to the concept of Radner equilibrium or the equilibrium with rational expectations. The possible definitions of equilibrium in the model are discussed below.

4.2.3 Equilibrium in the Basic Model

Up to this point, the model describes three markets: one for goods, one for capital and one for labor. Since the economy is described in real terms the price of goods is normalized to unity.

In the very first period, the old generation (which never was young) is endowed with s_0^{OW} for old workers and with s_0^{OE} for old entrepreneurs. The workers of the young generation decide upon c_1^{YW}, and the young entrepreneurs decide upon c_1^{YE}. Old entrepreneurs run firms and produce in total $Y_1 = (1-\eta)\, f\,(k_1, l_1)$, which is the aggregate supply of goods in the very first period. The aggregate demand for goods is given by the consumption of the old workers c_1^{OW} and old entrepreneurs c_1^{OE}, by the savings of young workers s_1^{YW} and of young entrepreneurs s_1^{YE}, as well as by the consumption of the young generation c_1^{YW} and c_1^{YE}. Taking into account the relative masses of workers and entrepreneurs in each generation, the equilibrium condition for the goods market in period 1 may be written as

$$(1-\eta) f(k_1, l_1) = \eta \left(c_1^{OW} + c_1^{YW}\right) + (1-\eta) \left(c_1^{OE} + c_1^{YE}\right) + \eta s_1^{YW} + (1-\eta) s_1^{YE} \quad (4.10)$$

In each period $t > 1$, the economy inherits the amount k_t of capital goods, which are used in the production in the period t, from the previous period. The aggregate output $Y_t = (1-\eta) f(k_t, l_t)$ of period t is used for the aggregate consumption of the old generation C_t^O and for the consumption C_t^Y and savings S_t^Y of the young generation. The aggregate consumption of the old generation consists of the consumption of old workers ηc_t^{OW} and of the consumption of old entrepreneurs $(1-\eta) c_t^{OE}$. The aggregate consumption of the young generation consists of the consumption of young workers ηc_t^{YW} and of the consumption of young entrepreneurs $(1-\eta) c_t^{YE}$. Finally, aggregate savings are given by the savings of young workers ηs_t^{YW} and those of young entrepreneurs $(1-\eta) s_t^{YE}$. For the goods market equilibrium in the period t this implies

$$(1-\eta) f(k_t, l_t) = \eta \left(c_t^{OW} + c_t^{YW}\right) + (1-\eta) \left(c_t^{OE} + c_t^{YE}\right) + \eta s_t^{YW} + (1-\eta) s_t^{YE} \quad (4.11)$$

with the functions c_t^{YW}, c_t^{OW}, c_t^{OE}, c_t^{YE}, s_t^{YW} and s_t^{YE} being the solutions of respective optimization problems:

c_t^{YW} and s_t^{YW} are solutions c_t and s_t of (**??**)

c_t^{OW} is a solution c_t of (**??**) applied to the life periods $(t-1, t)$

c_t^{YE} and s_t^{YE} are solutions c_t and s_t of (**??**)

c_t^{OE} is a solution c_t of (**??**) applied to the life periods $(t-1, t)$

Note that c_t^{YW}, s_t^{YW}, c_t^{YE} and s_t^{YE} depend on w_t, w_{t+1}^e and r_{t+1}. At the same time, c_t^{OW} and c_t^{OE} are either inherited from period $t-1$ as decisions (which surely may be implemented in the period t due to the absence of risk) or are determined by w_t, w_{t+1}^e and r_{t+1} and by savings s_{t-1}^{YW} and s_{t-1}^{YE}, which are inherited from period $t-1$. Due to Walras Law, as soon as w_t, w_{t+1}^e and r_{t+1} clear the market for labor and the market for capital, the market for goods is in equilibrium.

Since the focus here is on the dynamics of events in labor and capital markets, it suffices to determine the equilibrium in terms of these two markets. The resulting equilibrium prices are in real terms. Note as well that in the discussion above, the equilibrium in the first period may not be defined in the same way as the equilibria in further periods. I focus on periods distinct from the first one.

Taking this into the account, an equilibrium in the model may be defined as follows:

Definition 4.1 A **temporary equilibrium (TE)** in a period $t > 1$ is an array of the price vector $\left\{r_{t+1}^*, w_t^*\right\}$, wage expectations $\left\{w_{t+1}^{e*}\right\}$ and of the allocation vector $\left\{k_{t+1}^*, l_{t+1}^*, s_t^{E*}, s_t^{W*}\right\}$, which provides that:

(1) $(1-\eta)\left(k_{t+1} - s_t^E\right) = \eta s_t^W$

(2) $(1-\eta)\, l_t = 1.$

(3) $w_{t+1}^e = \mathbf{E}\left(w_{t+1} | \, \Omega_t\right)$

The first condition means that the credit market in period t clears, i.e. aggregate demand for credit (determined by the young entrepreneurs) is equal to aggregate supply of funds (determined by the young workers). The second condition means that the labor market in period t clears, i.e. aggregate demand for labor, which is created by old entrepreneurs (born in period $t-1$), equals to the aggregate supply of labor, created by the whole young generation (both young workers and young entrepreneurs born in period t, who have not yet started their businesses). Note that since the market clears in period t, the labor demand function depends on the actual instead of expected wage rate, and on the interest rate r_t inherited from the previous period: $l_t = l\left(r_t, w_t\right)$. The third condition describes the rule of the expectations formation.

Following Grandmont (1977), and using his notation, this can be associated with an "expectation function" $\psi\left(\mathfrak{s}_t\right) \in \mathcal{M}\left(\mathfrak{s}_{t+1}\right)$, which maps a signal $\mathfrak{s}_t$ (or a set $\mathfrak{S}_t$ of all signals available in period t) into the space of probability distributions $\mathcal{M}\left(\mathfrak{s}_{t+1}\right)$ over the value of the signal in the period $t+1$. Given the [estimated] probability distribution ψ, one can construct an expected value of $\mathfrak{s}_{t+1}$. Instead of a set of signals $\mathfrak{S}_t$, I consider the set of available information and techniques Ω_t (discussed below). Applying the concept of the expectation function to the wage w_{t+1}, one obtains the expected value w_{t+1}^e conditioned on the information set Ω_t. Remember that this expected value w_{t+1}^e is a parameter in the capital demand function

$k_{t+1} = k\left(r_{t+1}, w^e_{t+1}\right)$. Hence, the system of three equations in three unknowns above defines in any period t an equilibrium prices-expectations tuple $\left\{r^*_{t+1}, w^*_t, w^{e*}_{t+1}\right\}$, which gives the allocations $\left\{k^*_{t+1}, l^*_{t+1}, s^{E*}_t, s^{W*}_t\right\}$. Knowing this, one can calculate the resulting aggregate supply and the consumption of agents in each period $t > 1$ if necessary.

The set of the available information and techniques Ω_t in the simplest case may be viewed as a statistical data set on the past equilibria, in which case one obtains the rule of adaptive expectations. A general formulation of the temporary equilibrium does not require that the expected wage rate w^e_{t+1} clears the labor market in period $t+1$. However, in my model, agents of a generation t possess the following additional information: (1) the size of any generation is equal to unity; (2) labor supply is inelastic; and (3) labor market in period $t+1$ should clear. Assuming further that the agents can employ the technique of finding the equilibrium, one may replace the condition $w^e_{t+1} = \mathbf{E}\left(w_{t+1} | \Omega_t\right)$ with the condition of the perfect foresight

$$w^e_{t+1} = w_{t+1}$$

The capital demand function (**??**) now becomes $k_{t+1} = k\left(r_{t+1}, w_{t+1}\right)$.

Remark 4.1 Note that the old generation of the first period possesses the initial endowment $\left(s^E_0, s^W_0\right)$ and trades in two markets. First, in the market for credit with old entrepreneurs on the demand side and old "workers" on the supply side, in which the market equilibrium condition is $(1-\eta)\left(k_1 - s^E_0\right) = \eta s^W_0$. Second, in the market for labor with old entrepreneurs on the demand side and young generation on the supply side, in which the market equilibrium condition is $(1-\eta) l_1 = 1$. These two conditions determine the wage rate w_1 and the interest rate r_1. The interest rate is paid back to the old generation, which is irrelevant for the development of events. Hence, instead of endowing the first old generation with $\left(s^E_0, s^W_0\right)$, one can equivalently endow the first young generation with w_1 and focus on the equilibria in sense of the definition of temporary equilibrium above, starting from period $t = 1$.

The assumption of perfect foresight and the above remark allow one to define the general [intertemporal] equilibrium in the model.

Definition 4.2 A **general equilibrium (GE)** in this economy is given by a time path of the price vector $\left\{r^*_{t+1}, w^*_t\right\}^\infty_{t=1}$ and of the allocation vector $\left\{k^*_{t+1}, l^*_{t+1}, s^{E*}_t, s^{W*}_t\right\}^\infty_{t=1}$ under the initial wage endowment w_1 for the generation 1, which provides in every period $t \geq 1$ that

(1) $(1-\eta)\left(k_{t+1} - s^E_t\right) = \eta s^W_t$

(2) $(1-\eta) l_{t+1} = 1.$

This is Radner's (1972) type of equilibrium. The first condition requires that the credit market with the young entrepreneurs on the demand side and the young workers on the supply side clears in period t. The second condition describes the perfect foresight that the labor market in period $t+1$ clears. The Radner equilibrium - in contrast to the temporary equilibrium - requires that there is perfect foresight regarding the clearance of future markets. If several states of nature are possible in period $t+1$, the Radner equilibrium does not require that the agents of the period t have identical expectations regarding the probability distribution of these states of nature. The core of the Radner equilibrium is that the agents expect (or foresee) that the spot markets clear in each period in each state of nature. An assumption of rational expectations requires that if the agents use the same set of information to form their expectations, they should have identical subjective probability distributions regarding future states of nature. In this case, the Radner equilibrium reduces to rational expectations equilibrium (Lucas, 1972). In my model there is only one state of nature in each period, hence both Radner and rational expectations equilibria are the same.

Note that the price path $\left\{r_{t+1}^*, w_t^*\right\}_{t=1}^{\infty}$ in the definition of the general equilibrium above may be represented as a combination of the initial endowment w_1 and the price path $\left\{r_{t+1}^*, w_{t+1}^*\right\}_{t=1}^{\infty}$. One may think of it as though the young entrepreneurs born in period t agree amongst themselves upon a wage rate w_{t+1} to offer to the labor force, which will be born in period $t+1$. Then the actual competition among the entrepreneurs for the labor of period $t+1$ takes place in period t, and the entrepreneurs just fulfill their mutual agreement regarding the competitive wage rate in period $t+1$. This is possible due to the inelasticity of the labor supply. Hence, both competitive prices that determine the costs of period $t+1$, i.e. the interest rate r_{t+1} and the wage rate w_{t+1}, are found in period t. With this in mind, I present the following definition of a temporary equilibrium, which is more convenient in the analysis of the development of the economy:

Definition 4.3 A **temporary equilibrium with perfect foresight (TEPF)** in a period $t \geq 1$ with the parameter w_t is an array of the price vector $\left\{r_{t+1}^*, w_{t+1}^*\right\}$ and of the allocation vector $\left\{k_{t+1}^*, l_{t+1}^*, s_t^{E*}, s_t^{W*}\right\}$, which provides that

(1) $(1-\eta)\left(k_{t+1} - s_t^E\right) = \eta s_t^W$

(2) $(1-\eta)\, l_{t+1} = 1.$

Obviously, given an initial endowment w_1, the sequence of TEPFs will constitute a general equilibrium as defined above. The concept of TEPF is close to the definition of the equilibrium in Gersbach and Wenzelburger (2003). In the rest of the dissertation, if not specified, I will use the term "equilibrium" to refer to a TEPF.

Proposition 4.2 *The general equilibrium (GE) exists* if and only if *for any period* $t \geq 1$ *there exists a TEPF. The GE is unique* if and only if *the TEPF is unique in any period* $t \geq 1$.

The proof of the proposition is obvious, one just needs to compare the definitions of the GE and of the TEPF.

Proposition 4.3 *The TEPF exists and is unique for any period* $t \geq 1$ *if* $w_t > 0$.

Proof.

Existence

First, note that in any period t the TEPF is a static equilibrium. Given the parameter $w_t > 0$, the old generation (producers) possess a positive endowment s_t^E and s_t^W. The young generation possesses a unit endowment in labor force. The assumptions (**??** - **??**) satisfy the assumptions of the competitive equilibrium existence theorem (Arrow and Debreu, 1954; see also Debreu, 1959, and a weaker version of the existence theorem as formulated by Eichberger, 2004, Ch. 5):

(1) the set of available consumption vectors (c_t, c_{t+1}) for each generation t is closed and bounded from below

(2) the preferences of consumers of each generation t are represented by continuous, monotonically increasing, quasi-concave utility functions of (c_t, c_{t+1})

(3) the initial endowment of the individuals is strictly positive at least in one component (in the model in this chapter, each individual in each generation is endowed with one unit of labor, which is converted into $w_t > 0$ units of initial endowment in goods)

(4) production technologies belong to a part of each generation and are given by a continuous strictly increasing and concave production functions with no output at zero input.

The existence of an equilibrium follows, hence, from the above mentioned theorem.[40]

[40] Arrow and Debreu (1954) consider multiproduct technologies with an assumption that in the absence of factor

The proof of the uniqueness of the equilibrium below provides an additional support for the existence of the equilibrium, since it is based on the idea of finding the equilibrium and studying whether another constellation of the variables may exist, which still meets the definition of the equilibrium.

Uniqueness

Consider first labor market (LM). The LM-equilibrium condition is

$$l\left(r_{t+1}, w_{t+1}\right) = \frac{1}{1-\eta} \tag{4.12}$$

Function $l\left(r_{t+1}, w_{t+1}\right)$ decreases in both interest rate and wage level ($\frac{\partial l}{\partial r_{t+1}} < 0, \frac{\partial l}{\partial w_{t+1}} < 0$). The implicit function theorem guarantees that equation (**??**) defines a unique function $r_{t+1}\left(w_{t+1}\right)$ with $\frac{\partial r_t}{\partial w_{t+1}} < 0$. This means that for any given interest rate established in the credit market, there will always exist only one equilibrium wage level in the labor market.

Consider now the equilibrium in the credit market (CM):

$$(1-\eta)\left(k_{t+1} - s_t^E\right) = \eta s_t^W \tag{4.13}$$

Optimal choice of the entrepreneurs implies $\frac{\partial k}{\partial r_{t+1}} < 0, \frac{\partial k}{\partial w_{t+1}} < 0, \frac{\partial s_t^E}{\partial w_{t+1}} > 0$ and $\frac{\partial s_t^E}{\partial r_{t+1}} > 0$. Optimal choice of the workers implies $\frac{\partial s_t^W}{\partial w_{t+1}} < 0$ and $\frac{\partial s_t^W}{\partial r_{t+1}} > 0$. The sum and the difference of differentiable functions are differentiable. Hence, equation (**??**) also implicitly yields a differentiable function $r_{t+1}\left(w_{t+1}\right)$ which is unique.

Combining $r_{t+1}^{CM}\left(w_{t+1}\right)$, defined in the credit market, with $r_{t+1}^{LM}\left(w_{t+1}\right)$, defined in the labor market, we obtain an equilibrium interest rate and wage level, the existence of which is proven above. Assume that there are several equilibria and choose the one with the smallest $w_{t+1} = \underline{w}$. Consider now the difference $r_{t+1}^{CM}\left(w_{t+1}\right) - r_{t+1}^{LM}\left(w_{t+1}\right)$, which is zero in the equilibrium chosen. This difference increases as w_{t+1} increases (see Lemma **??** in Appendix **??** for proof):

$$\frac{\partial r_{t+1}^{CM}}{\partial w_{t+1}} - \frac{\partial r_{t+1}^{LM}}{\partial w_{t+1}} > 0 \tag{4.14}$$

Hence, the difference $r_{t+1}^{CM}\left(w_{t+1}\right) - r_{t+1}^{LM}\left(w_{t+1}\right)$ is positive for any $w_{t+1} > \underline{w}$. This means there are no equilibria with $w_{t+1} > \underline{w}$. Because of the choice of $\underline{w}$, there are also no equilibria

restrictions, the production of any good may be increased without a decrease in the production of other goods. Eichberger (2004) applies the theorem to the special case of one-product enterprises, which is exactly the case in my model. However, Eichberger (2004) uses the assumption of a stronger version of the theorem, which requires that *all* individuals are endowed with positive amount of *all* goods and production factors. Arrow and Debreu (1954) show that this assumption may be weakened.

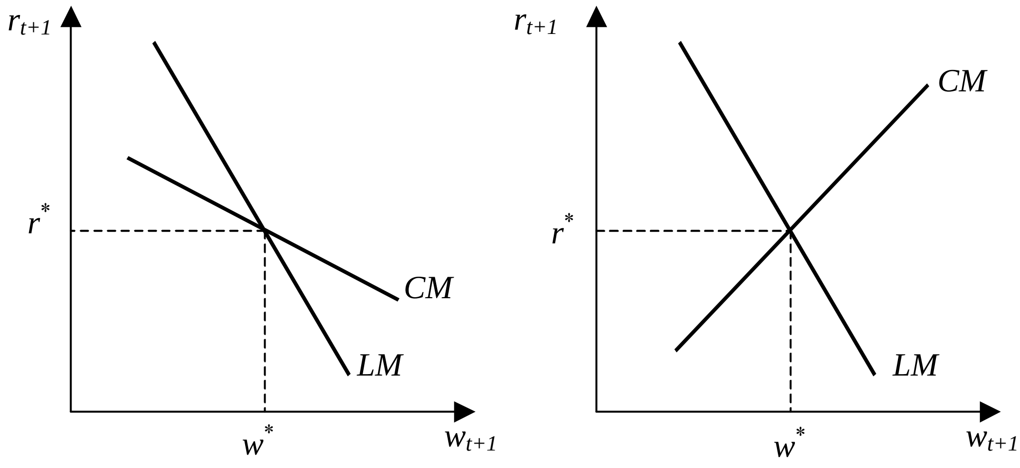

Figure 4.2. Temporary equilibrium with perfect foresight

with $w_{t+1} < \underline{w}$, This proves the uniqueness of the equilibrium point ($w^*_{t+1} = \underline{w}$, $r^*_{t+1} = r^{LM}_{t+1}(\underline{w}) = r^{CM}_{t+1}(\underline{w})$)

■

Note that the proposition above allows one to represent the equilibrium in terms of two lines in the (w_{t+1}, r_{t+1})-plane: LM depicting equilibria in labor market and CM depicting equilibria in credit market (see Fig. **??**).

Since the slope of the CM-line can be either negative or positive (but never smaller than the slope of the LM-line, see Lemma **??** in Appendix **??**), both cases are presented in the diagram.

4.2.4 Comparison with Benchmark Cases

To highlight the principal features of the OLG model above, I compare it with several benchmark models widely used in the literature on equilibrium macroeconomic dynamics.

4.2.4.1 Böhm and Puhakka (1988)

Böhm and Puhakka (1988) present a very simple OLG model to show how inefficient competitive equilibria can be dominated by equilibria with quantity constraints. The purpose of their study has little relevance to my analysis, but the basic setting can serve as a simple benchmark example.

They consider a producer-consumer (Robinson Crusoe), whom (for the sake of similarity to my model) one can consider as a unit size population of homogenous agents. All agents live for two periods. The young agents have an endowment of $\bar{l}$ units of leisure, which can be partially or completely used for work. Each young agent has access to a linear production technology, which produces a single perishable consumption good.

The agents only work when young and only consume when old. The preferences of the agents are given by a utility function with respect to leisure when young and consumption when old $u\left(l_t^0, c_{t+1}^1\right)$. As an initial condition, the old agents in the first period are endowed with one unit of money. The young agents of period t maximize their utility. This determines the labor supply in period t and the demand for good in period $t+1$. Due to the linear production technology (one unit of labor produces one unit of the good), the labor market is always in equilibrium, and hence vanishes from the analysis. The labor supply determines the supply of goods. Since the demand for goods of the period $t+1$ is determined by the agents of generation t, it depends on the money price of goods P_{t+1}, which is assumed to be known to the agents due to the perfect foresight.

Note that money plays an important role here. Money enables an intergenerational exchange, as suggested by Samuelson (1958). If money is taken out of the model, the young agents produce goods in the first period, but cannot sell them to the old agents, since the latter cannot offer anything in exchange. Money is therefore an essential element of the overlapping generations structure of Böhm and Puhakka (1988).

The model, therefore, describes two markets: one for goods (commodities) and one for money. Since in each period t a temporary equilibrium depends on the future price P_{t+1}, the general equilibrium in the model is defined as the whole path of prices: "*A sequence* $\{P_t\}_{t=1}^{\infty}$ *of prices is a* ***competitive equilibrium****, if for all* t *(a) the commodity market is cleared, (b) the money market is cleared, and (c) the condition of constant money stock is held.*"

I use effectively the same definition of general equilibrium. In my model production is deferred from the first to the second period in the lives of producing agents, and any two subsequent periods are parametrically linked through the wage rate. I also assume perfect foresight (rational expectations) regarding the future wage rate, as Böhm and Puhakka (1988) do. However, in my model, the calculation of the future wage rate does not require searching for the whole equilibrium path: young entrepreneurs possess all the necessary information to find the equilibrium wage rate of the next period due to the inelastic supply of labor.

The principal difference between my model and that of Böhm and Puhakka (1988) is that there is no need for money in my model. The young agents can exchange their labor for the goods, which they obtain from the old entrepreneurs. The goods can be transformed into capital at no costs. The resulting capital (together with the labor force of the next generation) generates new goods in the second period. Any debt-credit relationships appear only between the members of one generation.

4.2.4.2 Diamond (1965)

Diamond's (1965) model can be summarized as follows. At each date t, N_t agents are born, who live for two periods, t and $t+1$. Each of the agents is endowed with 1 unit of labor when young, having no other initial resources, when old. Agents of all generations are identical and have the same preferences, represented by a utility function $u\left(c_t^0, c_{t+1}^1\right)$ over their consumption streams $\mathbf{c}_t = \left(c_t^0, c_{t+1}^1\right)$. Here c_{t+i}^i represents the consumption of the agent born in period t when young ($i = 0$) and when old ($i = 1$). Each agent of generation t works when young and receives a wage w_t. He allocates this wage between current and future consumption "so as to maximize his utility function, given the rate of interest on one-period loans from period t to period $t+1$, r_{t+1}." Old agents only consume. The population is assumed to grow at the exogenous rate $n_g \geq 0$, so that $N_{t+1} = (1 + n_g) N_t$. In my model, I assume no population growth. Hence $n_g = 0$, and the size of the population is fixed: $N_t = 1$, $\forall t \geq 1$.

On the production side, there are infinitely lived firms (national economy), represented by a constant return to scale aggregate production function $F(K, L)$. The output of the firms can be used either directly for consumption or to create new capital, which takes one unit of the good to produce one unit of the new capital. Capital is durable and needs to be installed one period before it is used. Thus, the capital K_t is carried over from the period $t-1$. Although the rate of capital depreciation can be set to zero, Diamond's (1965) model is based on the assumption of capital accumulation: capital K_t used for production in period

t, is the capital stock K_{t-1} inherited from the period $t-1$ *plus* the new installment of capital out of the savings of the period $t-1$.

In my model, I assume no capital accumulation. Moreover, I do not assume that the firms exist infinitely long. On the contrary, the firms are founded by the entrepreneurs and exist for only one period, namely when the entrepreneurs are old. The firms are closed when the entrepreneurs die, and the capital of the firms is not transferred into the next periods, but is rather consumed completely within the second period of lives of the respective entrepreneurs. The firms in my model are therefore considered as a storage technology for the transfer of savings from one period to another.

Diamond (1965) introduces "entrepreneurs" as "capital demanders" (as do Bencivenga and Smith, 1991, who consider the general equilibrium in presence of banks, which will be a further step in my analysis), but they are not modelled explicitly and just represent the firms. Alternatively, Diamond's entrepreneurs can effectively be considered as workers (just they work as firms' managers), and, hence, the intertemporal choice problem for entrepreneurs and workers is the same. In my model, the entrepreneurs' choice regarding their consumption stream (and saving) depends on the expected profit they obtain from running the firms. In this sense, the production sector is endogenized in spirit of Gersbach and Wenzelburger (2003).

Although I do not employ the assumption of the infinitely lived firms, the problem of intergenerational lending (Samuelson, 1958) does not arise (see above).

4.2.4.3 Bernanke and Gertler (1987, 1989, 1990)

In a series of three papers, which all first appeared as NBER Working papers,[41] Bernanke and Gertler suggest macroeconomic models with an emphasis on financial markets. In Bernanke and Gertler (1987) the OLG structure with financial intermediation is based upon the Diamond and Dybvig (1983) setting, which presumes that the generations live for three periods. I will discuss the applicability of the Diamond and Dybvig (1983) setting to my model below, as I introduce financial intermediation into the model. Bernanke and Gertler (1989 and 1990) do not consider financial intermediation explicitly, but I refer to these papers here in order to provide the comparison of equilibrium concepts.

[41] Bernanke and Gertler (1987) was initially a NBER WP 1647 of 1985; Bernanke and Gertler (1989) was a NBER WP 2015 of 1986; and Bernanke and Gertler (1990) was a NBER WP 2318 of 1987.

Bernanke and Gertler (1990) effectively consider a stochastic version of the Diamond (1965) model. This paper is a good reference paper for an analysis of the macroeconomies under exogenous shocks. Similar to the parametrized TEPF in my model, Bernanke and Gertler (1990) introduce and analyze a *momentary equilibrium*, which takes the inherited capital stock from the previous period as given (in my model the link between two periods is effectively the wage rate). As in Diamond (1965), the labor market is not analyzed in Bernanke and Gertler (1990).

The basic OLG setting in Bernanke and Gertler (1989) is relatively close to that of Böhm and Puhakka (1988): individuals obtain an exogenous endowment in the first period of their lives, only save (or invest) in the first period, and only consume in the second period of their lives. The initial endowment in goods can be understood as the result of work, and is equivalent to the leisure endowment in the model of Böhm and Puhakka (1988). Again, the labor market is not explicitly modeled.

4.3 The Model with Financial Intermediation

The basic model above assumes the existence of a credit market, in which the borrowers (entrepreneurs) and lenders (workers) can trade with savings/loans. This requires that the entry to the credit market is free of charge for both entrepreneurs and for workers, and that there are no search costs. Moreover, this requires that the workers trust the entrepreneurs when they buy their promissory notes, and that the entrepreneurs do not cheat on the production outcome. If one of these assumptions fails, the credit market fails to link borrowers and lenders, and the economy obviously fails to achieve pareto-efficiency. The key point of the inefficiency is that the workers consume less when old (due to the absence of interest payment), and the entrepreneurs produce less, and therefore consume less as well.

It can be argued that a financial intermediary can perform better in such a situation than the market, since financial intermediaries have a cost advantage in certain tasks. As Leland and Pyle (1977) write, "if transaction costs are not present, ultimate lenders might just as well purchase the primary securities directly and avoid the costs, which intermediation might involve". Transaction costs can explain intermediation, although they are mostly not the sole cause for intermediation to exist. Two other possible explanations for financial intermediation dominate in the literature: information costs advantage and assets transformation (I discussed these and other *raisons d'être* for financial intermediation in Chapter 1).

Diamond (1984) shows that a financial intermediary has a net advantage relative to direct lending and borrowing. The core of the idea is that there is an informational asymmetry between the borrowers and lenders. An intermediary can provide a reduction in informational costs, if the portfolio of credits is diversified. Diversification plays hence a crucial role even in the world of risk-neutral agents.

Diamond and Dybvig (1983) suggest that a financial intermediary creates liquidity provisions for depositors, who are uncertain regarding their consumption timing plans. The approach of Diamond and Dybvig (1983) is employed, for example, by Bencivenga and Smith (1991) and Bernanke and Gertler (1987) in their general equilibrium models with financial intermediation.

In the following section, I embed a system of financial intermediaries into the overlapping generations model developed above. I still choose a transaction costs justification of the intermediation, since it does not require any changes in the model. To use an information costs approach, one would have to assume some uncertainty about the outcomes of production. To use the liquidity provision approach, one would have to consider an uncertainty in consumption plans of lenders, and (possibly) introduce agents, who live for three periods. The model in the current chapter incorporates no uncertainty, and the agents live only for two periods. Therefore, the transaction costs approach is more appropriate. Moreover, Chapter 5 compares the development of the market and the intermediated economy after a macroeconomic shock, which reveals comparative advantages for the intermediated economy. This may be seen as intertemporal risk smoothing, which itself may be a justification of the existence of the intermediation.

4.3.1 Agents and Decisions

Consider an arbitrary generation t. The whole generation works and saves, as before. The potential entrepreneurs plan their optimal production for the next period. However, there is no well-functioning credit market. Therefore, the entrepreneurs cannot obtain funds directly from workers to acquire the needed capital stock k_{t+1}, which exceeds their savings

s_t^E. Instead, there exists a system of financial intermediaries, who collect funds from workers and lend them to entrepreneurs.

The optimization problem of the workers is the one given above, except that the interest paid on their savings in the second period of their lives is the interest on deposit contracts r_{t+1}^D:

$$\begin{aligned} u\left(c_t, c_{t+1}\right) &\rightarrow \max_{c_t, c_{t+1}, s_{t+1}^W} \\ \text{s.t. } c_t &= w_t - s_t^W \\ c_{t+1} &= \left(1 + r_{t+1}^D\right) s_t^W \end{aligned} \tag{4.15}$$

As a solution to this optimization problem, one again has the savings function of workers (depositors)

$$s_t^W \left(\underset{+}{r_{t+1}^D}, \underset{+}{w_t} \right)$$

The sign "+" under the variables indicates positive dependence of the function on its arguments.

Potential entrepreneurs solve their respective utility maximization problem, which uses now the credit interest rate r_{t+1}^C, charged by the intermediaries for credits granted:

$$\begin{aligned} u\left(c_t, c_{t+1}\right) &\rightarrow \max_{c_t, c_{t+1}} \\ \text{s.t. } c_t &= w_t - s_t^E \\ c_{t+1} &= E_{t+1}^e\left(s_t^E, w_{t+1}, r_{t+1}^C\right) \end{aligned} \tag{4.16}$$

As before, E_{t+1}^e denotes the expected profit in the period $t+1$. Taking into account the assumption of perfect foresight, I replace the expected wage rate w_{t+1}^e in the profit function with the known future wage rate w_{t+1}. The profit maximization problem of the entrepreneurs is effectively the same as before, up to the notation of the interest rate:

$$f\left(k_{t+1}, l_{t+1}\right) - \left(1 + r_{t+1}^C\right)\left(k_{t+1} - s_t^E\right) - w_{t+1} l_{t+1} \rightarrow \max_{k_{t+1}, l_{t+1}} \tag{4.17}$$

and the solution of this problem for any level of savings s_t^E appears as

$$k\left(r_{t+1}^C, w_{t+1}\right) : \frac{\partial k}{\partial r_{t+1}^C} < 0, \frac{\partial k}{\partial w_{t+1}} < 0 \tag{4.18}$$

$$l\left(r_{t+1}^C, w_{t+1}\right) : \frac{\partial l}{\partial r_{t+1}^C} < 0, \frac{\partial l}{\partial w_{t+1}} < 0 \tag{4.19}$$

The saving function of the entrepreneurs is effectively the same as before:

$$s_t^E = s^E \left(\underset{+}{w_t}, \underset{-}{w_{t+1}}, \underset{+}{r_{t+1}^C} \right) \tag{4.20}$$

Again, the signs "+" and "-" under the variables indicate respectively positive or negative dependence of the function on its arguments.

4.3.2 Intermediation and Interactions

Financial intermediation is represented in the economy through banks, which collect savings from workers in the form of deposits, and offer credits to entrepreneurs. I assume the capital of financial intermediaries to be zero. They can be, for example, seen as mutual funds. Another possibility would be to imagine that financial intermediaries have negligibly small capital and belong to the old generation in each period t. The ownership is then transferred from one generation to another through bequests and no market for banks' stocks is considered. The ownership could change budget constraints in the optimization problems of workers (**??**) and entrepreneurs (**??**) through dividend payments, but due to zero profit of banks in competition (see below), such dividend payments are zero as well. Due to its homogeneity, the banking system is further considered as a whole, except for considerations regarding competitive outcome.

The collection of deposits starts in period t, when the workers of the generation t create their savings s_t^W. In the end of period t, entrepreneurs apply for credits to start their business (run firms). Payouts of the entrepreneurs to banks take place within period $t+1$.

Since there is no other storage technology available in the economy, the value of deposits made with the banks is equal to the value of aggregate savings of the workers: ηs_t^W. In period $t+1$ banks have to repay $\eta\left(1 + r_{t+1}^D\right) s_t^W$ to depositors.

Entrepreneurs apply for credits in the amount needed to finance their investment demand. It is assumed that no credit rationing takes place, and therefore no credit application is rejected. The amount of credit granted totals $(1-\eta)\left(k_{t+1} - s_t^E\right)$. Investment (in production technology) takes place at the end of period t. Within period $t+1$ all entrepreneurs repay to the banks $B_{t+1} = (1-\eta)\left(1 + r^C_{t+1}\right)\left(k_{t+1} - s^E_t\right)$.

The aggregated balance sheet of the banks is given by the balance sheet equation:

$$(1-\eta)\left(k_{t+1} - s^E_t\right) = \eta s^W_t \tag{4.21}$$

The left-hand side of this equation represents the total assets of the banking system, and the right-hand side represents the liabilities. Note that the balance-sheet equation (**??**) replicates the condition of the credit market equilibrium in definition **??**.

Since banks operate in a competitive environment, neither deposit rates r^D_{t+1} nor credit rates r^C_{t+1} differ among banks. This is why I omit any indexes corresponding to individual banks, taking interest rates as uniform in the market. Moreover, in this competitive environment, either banks set credit and deposit interest rates equal to each other (see e.g. Gersbach, 2003, for discussion for the case with market-side switching) or take them equal to each other, as given by the market, so that in a pure competitive environment $r^D_{t+1} = r^C_{t+1} = r_{t+1}$ (see e.g. Baltensperger and Jordan, 1997).

Proposition 4.4 *Competition in the banking system implies* $r^D_{t+1} = r^C_{t+1} = r_{t+1}$

The proof of the proposition is obvious. It follows from the fact that the expected profit of the banks is equal to zero under competition in the banking system. Also compare this with Proposition 3.7: if the regulator follows regulatory forbearance with the probability $z = 1$, the competitive equilibrium deposit rate is equal to the expected rate of return on the banks' investment portfolio, which is exactly r^C_{t+1}.

The timing of events in the economy with financial intermediation is presented in Figure **??**

4.3.3 Markets and Equilibrium

We now have four markets in the model. The goods market is not considered because of the same considerations as in the basic model. The three other markets are the credit market, the deposits market, and the labor market.

Definition 4.4 A **temporary equilibrium with perfect foresight (TEPF)** in a period $t \geq 1$ under the parameter w_t in the intermediated economy is an array of the price vector $\left\{r^{C*}_{t+1}, r^{D*}_{t+1}, w^*_{t+1}\right\}$ and of the allocation vector $\left\{k^*_{t+1}, l^*_{t+1}, s^{E*}_t, s^{W*}_t\right\}$, which provides that

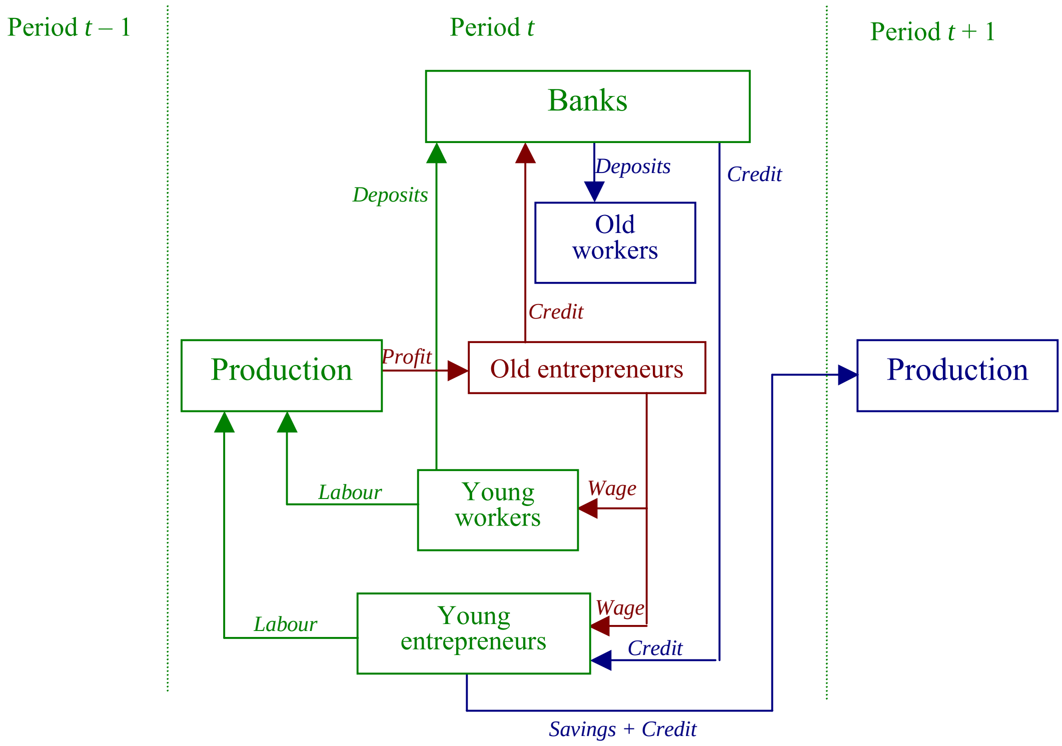

Figure 4.3. Sequence of events in the intermediated economy

(1) $(1-\eta)\left(k_{t+1}-s_t^E\right)=\eta s_t^W$

(2) $(1-\eta)\,l_{t+1}=1.$

(3) $r_{t+1}^D=r_{t+1}^C$

The first equation in this definition is now a balance sheet equation of the banks. The second equation, as before, determines the labor market equilibrium. Finally, the third equation describes the competitive outcome in the banking sector.

Note that since the interest rates in the credit and deposit markets are equal, the definitions of the temporary equilibrium with perfect foresight for the market (Definition **??**) and for the intermediated economy (Definition **??**) coincide. Hence, Proposition **??** is also valid for the intermediated economy:

Proposition 4.5 *The TEPF in the intermediated economy exists and is unique for any period* $t\geq 1$ *if* $w_t>0$.

It is important that definitions **??** and **??** are extremely similar. The fact that the functional form of the market equilibrium equations is the same, combined with the fact that the equilibrium exists and is unique, leads to a conclusion that the equilibrium allocation $\left\{k_{t+1}^{*}, l_{t+1}^{*}, s_{t}^{E*}, s_{t}^{W*}\right\}$ in the intermediated economy is the same as in the market economy. It is achieved with the same price system $\left\{r_{t+1}^{*}, w_{t+1}^{*}\right\}$ with $r_{t+1}^{*} = r_{t+1}^{C*} = r_{t+1}^{D*}$ if the parameter w_t is the same for both economies. Since the market economy, as in Chapters 2 and 3, is considered to be an efficiency benchmark, one can claim that the financial intermediation in the current chapter provides the economy with an efficient allocation of resources in period t, no matter with which initial endowment w_t the economy starts period t. This leads to the following

Corollary 4.1 *The market economy and the intermediated economy are statically equivalent in the sense that the temporary equilibria in both systems in any period t are identical with regard to the allocation and to the price system, given the same initial endowment w_t.*

Further consideration with respect to the temporary equilibria concerns the role of the parameter w_t. What happens if the parameter w_t is different in the intermediated economy from that in the market one? May one expect that a steady state exists, and if so, may one expect that the steady state for the market economy is the same as for the intermediated one? And finally, are the general equilibria (as defined in Definition **??**) in both economies identical? The answer to these questions would allow one to judge about the dynamic efficiency of the intermediated economy. In the next section, I establish an important fact with regard to the evolution of the economy and to the steady state.

4.4 Evolution of the Economy

Consider now the development of events in the economy. Assume some initial condition w_1 is given. I first consider the market economy and then extend the result to the case of the intermediated one.

Proposition 4.6 *The market economy converges to a steady state (stationary point), which is stable.*

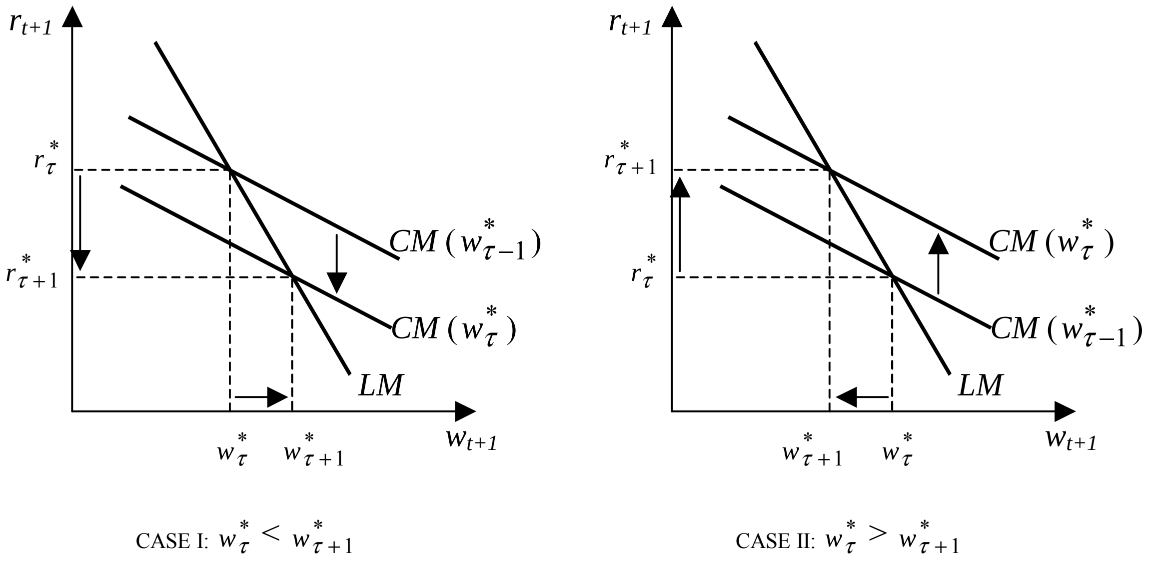

Figure 4.4. Steady state (stationary point) in the economy

The idea of Proposition **??** is illustrated in Figure **??**. The position of the CM-line in any period $\tau \geq 1$ is parametrically determined by the equilibrium wage level w_τ realized in the period $\tau - 1$ (for the period $\tau = 1$, it is determined by the initial condition w_1). The proof of Proposition **??** is based upon the fact that the CM-line in a period τ shifts downwards with the increase in w_τ. If in some period τ, the equilibrium wage rate $w_{\tau+1}$ is established at the level $w_{\tau+1} > w_\tau$, then the CM-line in the subsequent period $\tau + 1$ is positioned lower than in the period τ, which implies that the new equilibrium wage rate $w_{\tau+2}$ is higher than $w_{\tau+1}$. Hence, the sequence of equilibrium wage rates $\{w_\tau\}_{\tau=1}^{\infty}$ is monotonically increasing. The boundedness of a monotonic sequence guarantees its convergence.[42] Hence, a steady state exists.

The uniqueness of the steady state follows from the uniqueness of the TEPF in any period t for any positive parameter w_t. This implies that there exists a unique TEPF for some $w_t = w_{t+1}$, which is a steady state condition. This yields a unique $\widetilde{w} = w_t = w_{t+1}$, which

[42] This implicitly assumes that there exists such upper bound w^u that $0 < w_t < w^u$, and such upper bound r^u that $0 < r_t < r^u$, $\forall t$. If these conditions are violated, it is possible that the system does not possess a stable steady state. Then, the discussion below is still true, but it is then hard to track whether the crisis is due to the special features of the economy, or is generated by the specifics of its financial system. Focusing on economies with stable steady states allows one to show that a crisis (financial collapse) is a specific feature of the banking economy.

determines the steady state. It is important that the steady state does not depend on the initial condition, since it is given by a TEPF, with a particular property $w_t = w_{t+1}$.

To establish the stability of the steady state, assume that the economy has settled in a steady state with the wage rate $\widetilde{w}$. Consider now an arbitrary deviation from the steady state given by an initial condition $w_1 < \widetilde{w}$. From the above discussion it follows that the sequence $\{w_\tau\}_{\tau=1}^{\infty}$ generated by the initial condition w_1 converges to $\widetilde{w}$, which is only possible if in any period $w_{\tau+1} > w_\tau$, otherwise there should exist another steady state, which is a contradiction.

To extend the result for the case of the intermediated economy, it suffices to note that the definition of a TEPF for an intermediated economy coincides in the current chapter with the definition of a TEPF for the market one. Hence, the intermediated economy exhibits the same properties as the market one.

Proposition 4.7 *The intermediated economy converges to a steady state (stationary point), which is stable and replicates the steady state of the market economy.*

4.5 Equivalence

Propositions **??** and **??** in the previous section prove the following

Corollary 4.2 *The market economy and intermediated economy are dynamically equivalent.*

Note that this result is obtained due to the identity in the balance sheets of the market economy and the intermediated one. The important assumption in this chapter was the absence of risk in any form. This allowed one to neglect the crucial difference between direct debt contracts and indirect lending through deposit contracts: the debt contract presumes limited liability of the issuer and the deposit contract presumes unlimited liability of the bank under the assumption of workout incentives of the future generations.

The existence of a single stable stationary equilibrium point (which in Diamond, 1965, is rather an assumption) is the starting point of the analysis in the next chapter. In the above analysis, I studied the deviation from a stationary point caused by a change in wage endowment, which may be interpreted as though workers have not been paid for their work in full, and hence save less and consume less. A possible explanation for that could be a production shock. If the identity between the balance sheets of the market and the intermediated economy is not destroyed, both of them recover to the steady state simultaneously.

Obviously, this depends on the priority of repayments adopted in the economy. If entrepreneurs first repay their debts, and after that repay their wage obligations, the identity between the financial market equilibrium condition and the banks' balance sheet is not disturbed. If, however, the entrepreneurs suffer from insufficient production, and the wage payments are made prior to the debt repayments, then the deviation of w from its stationary level is only possible if the entrepreneurs cannot repay their debts. In the market economy, old creditors are not repaid, but they cannot influence the further development of events, since the latter is determined only by young agents. In the intermediated economy, it is the banks who are not repaid. Formally, these banks are bankrupt, and several scenarios are possible.

In Chapters 2 and 3, I considered different failure resolution procedures. First, a regulator may liquidate banks, in which case their depositors are not repaid exactly as the creditors in the market economy. The new generation founds new banks (as in Chapter 3), and the intermediated economy replicates the market one. Nonetheless, note that the commitment to liquidation would change the competitive outcome with respect to the deposit interest rate (Proposition **??** may be violated).

Secondly, the regulator may collect taxes from the current depositors in order to enable banks to repay deposits in full. Again, the depositors internalize the costs of such bailout, and the intermediated economy replicates the market one. Any failure resolution, which makes depositors completely internalizing the costs of bailout/liquidation, would lead to the replication of the market outcome. Note that in the presence of risk, this may still lead to inefficiency of intermediation, as in Chapter 2.

Finally, the regulator may choose a failure resolution procedure with no internalization of the bailout costs by the current depositors or to forbear. If it is a young generation who bails the banks out, their savings differ from those in the market economy, and the evolution of the intermediated economy does not replicate the market one anymore. For the case of forbearance, I showed in Chapter 3 (Section 3.8) that the banks may experience deficits if their loans are not repaid in full. The existence of such deficits would change the balance sheet of the banks, and the intermediated economy follows a different development path after the deviation from a stationary point. I discuss the issue of the difference in the evolution of the market economy and of the intermediated one in the next chapter.

4.6 Summary

In this chapter, I presented an overlapping generations general equilibrium setting to analyze the role of financial markets and financial intermediation in a dynamic context.

First, it is established that in the absence of risk, the market and the intermediated economy provide the same equilibrium allocation and the same equilibrium price system. It is important that the intermediation is competitive, otherwise the price system will not be identical in both economies anymore. Remember from Chapters 2 and 3 that the monopolist bank sets the interest rate below that of the competitive banks, and the monopolistic rent may lead to wealth distortions if not all depositors are shareholders of the banks.

Secondly, both intermediated and market economies converge to the same steady state if the initial wealth endowment of the very first generation is the same. It follows as well that the development path of both economies is the same, and, hence, they provide the same general (intertemporal) equilibria. Therefore, in the absence of risk, financial intermediation is not only statically but also dynamically efficient.

The absence of risk is an important factor for efficiency. In Chapter 3 (Section 3.8), I showed that the banking system may inherit deficits from one period into another if the regulator follows the policy of forbearance or if the workout incentives make the banks internalizing the costs of bailouts. This is the crucial difference between the market economy and the intermediated one. In the market economy, if an entrepreneur is not able to pay on his obligations, the principle of limited liability holds, and the creditor suffers losses. Such a situation is impossible in the setting adopted in the current chapter, since perfect foresight and no risk do not allow for an insolvency of the borrowers: they are always able to pay on their obligations. Since no difference appears in the aggregate balance sheets of the market and the intermediated economy, one obtains no difference in the equilibrium dynamics.

In the next chapter, I introduce an external shock which disturbs the system. This will reveal the above outlined difference between the two economies. The purpose of Chapter 5 is to apply the analysis of the current chapter to shock-driven dynamics. Since external shocks belong to the triggering mechanisms of financial crises, Chapter 5 provides an important contribution to the discussion on how the financial system should be structured and regulated in order to minimize the harmful effects of financial crises in an economy.

Appendix 4.A

Proofs

Proof of Proposition **??**

Proof.

For notational needs, we will distinguish between two types of optimization problems:

(I) Entrepreneurs decide first on the optimal amount of capital and labor needed for optimal production in the sense of profit maximization. They consider, therefore, their savings level as exogenously given. They then decide upon the optimal savings level, given an optimal production plan.

(II) Entrepreneurs simultaneously decide how much capital and labor they need for production, and how much savings they need to make. In this case, they consider savings level to be endogenous.

Consider first the solution of the profit maximization problem which does not depend on the savings decision (optimization problem of the type I).The first-order conditions (FOC) for this problem are

$$
\begin{aligned}
f_k - (1+r) &= 0 \qquad (4.A.1)\\
f_l - w &= 0
\end{aligned}
$$

with f_k and f_l being first derivatives of the production function with respect to capital and labor respectively.

We will now show that the solution delivers an optimum to the simultaneous profit-savings optimization problem (II) as well. The FOC for the profit maximization problem (II) is:

$$
\begin{aligned}
f_k - (1+r) + (1+r)\frac{\partial s^E}{\partial k} &= 0\\
f_l - w + (1+r)\frac{\partial s^E}{\partial l} &= 0
\end{aligned}
$$

so that for the proof it suffices to show that the solution of problem (I) is at the same time a solution of problem (II).

In the settings of problem (I), the FOC for the utility maximization is:

$$-u_1 + (1+r)\,u_2 = 0$$

with u_1 and u_2 being derivatives of the utility function with respect to its first and second arguments respectively. Differentiating this equation with

respect to capital and using the budget constraints from the utility maximization problem delivers the derivative $\frac{\partial s^E}{\partial k}$:

$$\frac{\partial s^E}{\partial k} = (f_k - (1+r)) \frac{u_{12} - (1+r)\,u_{22}}{u_{11} - 2\,(1+r)\,u_{12} + (1+r)^2\,u_{22}}$$

Substituting this into the FOC for capital for problem (II) yields

$$\left[\frac{u_{12} - (1+r)\,u_{22}}{u_{11} - 2\,(1+r)\,u_{12} + (1+r)^2\,u_{22}} + 1\right](f_k - (1+r)) = 0$$

The term in square brackets in this equation is always positive due to the properties of the utility function. Therefore, the only possibility for an optimum is that the second bracket is zero, which coincides with the FOC (**??**) for the problem (I). The same is true for labor. Hence, the independently made optimal choice coincides with optimal simultaneous choice, i.e. the solution of problem (I) delivers an optimum to problem (II) and decisions upon optimal production and optimal savings can be separated.

■

The intuition behind this proposition is that the optimization of production involves the choice of the optimal amount of capital, and not that of the credits solely, which are capital minus savings of entrepreneurs. Another intuition is that entrepreneurs could have made their savings in the form of deposits, which would yield the same interest rate as that on credits. In this case, the problem is equivalent, but it makes clear that the savings and production decisions are separated.

Lemma 4.1 Equilibrium gap $r^{CM}_{t+1}(w_{t+1}) - r^{LM}_{t+1}(w_{t+1})$ increases in w_{t+1}

Proof. The slope of the equilibrium line in the credit market can be found through implicit differentiation:

$$\frac{\partial r_{t+1}}{\partial w_{t+1}} = -\frac{\eta \frac{\partial s^W_t}{\partial w_{t+1}} - (1-\eta)\left(\frac{\partial k}{\partial w_{t+1}} - \frac{\partial s^E_t}{\partial w_{t+1}}\right)}{\eta \frac{\partial s^W_t}{\partial r_{t+1}} - (1-\eta)\left(\frac{\partial k}{\partial r_{t+1}} - \frac{\partial s^E_t}{\partial r_{t+1}}\right)} \tag{4.A.2}$$

The denominator in this fraction is always positive. Since (**??**) is valid for any value of the parameter $\eta \in (0,1)$ we can check, whether it is positive or negative for its upper and lower limits:

$$\left\{\frac{\partial r_{t+1}}{\partial w_{t+1}}\right\}^{CM}_{\eta=0} = -\frac{\frac{\partial k}{\partial w_{t+1}} - \frac{\partial s^E_t}{\partial w_{t+1}}}{\frac{\partial k}{\partial r_{t+1}} - \frac{\partial s^E_t}{\partial r_{t+1}}} < 0 \tag{4.A.3}$$

$$\left\{\frac{\partial r_{t+1}}{\partial w_{t+1}}\right\}^{CM}_{\eta=1} = -\frac{\frac{\partial s^W_t}{\partial w_{t+1}}}{\frac{\partial s^W_t}{\partial r_{t+1}}} > 0 \tag{4.A.4}$$

This means that for all possible functions k, s^E and s^W, setting $\eta = 0$ (and close to it) guarantees that CM-line is monotonically decreasing in w_{t+1}; and setting $\eta = 1$ (and close to it) guarantees that CM-line is monotonically increasing in w_{t+1} for any given wage parameter w_t.

Furthermore, for each set of functions k, s^E and s^W, the slope of the CM-line monotonically increases in η as η changes from 0 to 1:

$$\frac{\partial}{\partial \eta}\left\{\frac{\partial r_{t+1}}{\partial w_{t+1}}\right\}^{CM} = -\frac{\frac{\partial s^W_t}{\partial r_{t+1}}\frac{\partial k}{\partial w_{t+1}} - \frac{\partial s^W_t}{\partial w_{t+1}}\frac{\partial k}{\partial r_{t+1}}}{\left[\eta\frac{\partial s^W_t}{\partial r_{t+1}} - (1-\eta)\left(\frac{\partial k}{\partial r_{t+1}} - \frac{\partial s^E_t}{\partial r_{t+1}}\right)\right]^2} > 0 \tag{4.A.5}$$

This ensures that at any point w_{t+1} the derivative $\frac{\partial r_{t+1}}{\partial w_{t+1}}$ is always bounded by (**??**) from below and by (**??**) from above. Since $\left\{\frac{\partial r_{t+1}}{\partial w_{t+1}}\right\}^{LM} < \left\{\frac{\partial r_{t+1}}{\partial w_{t+1}}\right\}^{CM}_{\eta=0}$ (for proof see Lemma **??** below), the slope of the LM-line is smaller than the smallest possible slope of the CM-line in any point w_{t+1}, so that the gap $r^{CM}_{t+1} - r^{LM}_{t+1}$ increases in w_{t+1}.[43]

■

Lemma 4.2 The slopes of the LM- and CM-lines are related with

$$\left\{\frac{\partial r_{t+1}}{\partial w_{t+1}}\right\}^{LM} < \left\{\frac{\partial r_{t+1}}{\partial w_{t+1}}\right\}^{CM}_{\eta=0} \tag{4.A.6}$$

Proof. The slope of the LM-line is given by

$$\left\{\frac{\partial r_{t+1}}{\partial w_{t+1}}\right\}^{LM} = -\frac{\frac{\partial l}{\partial w_{t+1}}}{\frac{\partial l}{\partial r_{t+1}}} \tag{4.A.7}$$

The slope of the CM-line is given by

$$\left\{\frac{\partial r_{t+1}}{\partial w_{t+1}}\right\}^{CM} = -\frac{\eta\frac{\partial s^W_t}{\partial w_{t+1}} - (1-\eta)\left(\frac{\partial k}{\partial w_{t+1}} - \frac{\partial s^E_t}{\partial w_{t+1}}\right)}{\eta\frac{\partial s^W_t}{\partial r_{t+1}} - (1-\eta)\left(\frac{\partial k}{\partial r_{t+1}} - \frac{\partial s^E_t}{\partial r_{t+1}}\right)} \tag{4.A.8}$$

[43] It suffices to consider the derivative of this gap.

Choose $\eta = 0$. We need to prove that

$$-\frac{l_w}{l_r} < -\frac{k_w - s_w^E}{k_r - s_r^E} \tag{4.A.9}$$

where k_w, l_w, s_w^E, k_r, l_r, and s_r^E denote derivatives of the respective functions.

This last condition is fulfilled as soon as

$$l_w k_r - l_w s_r^E > k_w l_r - s_w^E l_r \tag{4.A.10}$$

Consider the properties of factor demands[44]:

$$l_w = \frac{f_{kk}}{f_{kk} f_{ll} - (f_{kl})^2} < 0 \tag{4.A.11}$$

$$k_w = l_r = \frac{-f_{kl}}{f_{kk} f_{ll} - (f_{kl})^2} < 0 \tag{4.A.12}$$

$$k_r = \frac{f_{ll}}{f_{kk} f_{ll} - (f_{kl})^2} < 0 \tag{4.A.13}$$

Hence

$$k_w l_r - l_w k_r = \frac{(f_{lk})^2 - f_{kk} f_{ll}}{\left[f_{kk} f_{ll} - (f_{kl})^2\right]^2} < 0 \tag{4.A.14}$$

Combining this with $s_w^E < 0$ and $s_r^E > 0$, we obtain

$$-l_w s_r^E > k_w l_r - l_w k_r - s_w^E l_r \tag{4.A.15}$$

The latter inequality is true, since the left-hand side is positive and the right-hand side is negative. This proves **??** and consequently the statement of the Lemma.

■

Lemma 4.3 For any wage rate w_{t+1}, the equilibrium interest rate in the credit market equilibrium positively depends on the equilibrium wage rate of the previous period:

$$\frac{\partial r_{t+1}^{CM}}{\partial w_t} < 0$$

Proof.

Consider the equilibrium condition for the credit market:

$$(1 - \eta)\left(k_{t+1} - s_t^E\right) = \eta s_t^W$$

[44] The denominator $f_{kk} f_{ll} - (f_{kl})^2$ has to be positive, due to a standard assumption regarding the substitution effect.

Here $k_{t+1} = k\left(\underset{-}{w_{t+1}}, \underset{-}{r_{t+1}}\right)$, $s_t^E = s^E\left(\underset{+}{w_t}, \underset{-}{w_{t+1}}, \underset{+}{r_{t+1}}\right)$ and $s_t^W = s^W\left(\underset{+}{w_t}, \underset{+}{r_{t+1}}\right)$. The implicit function theorem implies:

$$\frac{\partial r_{t+1}}{\partial w_t} = \frac{\frac{\partial s^E}{\partial w_t} + \frac{\eta}{1-\eta}\frac{\partial s^W}{\partial w_t}}{\frac{\partial k}{\partial r_{t+1}} - \frac{\partial s^E}{\partial r_{t+1}} - \frac{\eta}{1-\eta}\frac{\partial s^W}{\partial r_{t+1}}} < 0$$

■

Proof of Proposition **??**

Proof.

First, note that the credit market equilibrium implies for any period $t \geq 1$:

$$\frac{\partial r_{t+1}^{CM}}{\partial w_t} < 0 \tag{4.A.16}$$

See Lemma **??** for proof.

The initial condition w_1 determines the equilibrium $\{r_2^*, w_2^*\}$. The equilibrium interest rate r_2^* plays no role in the further dynamics, since the next equilibria are parametrized only on the wage rate. If $w_1 = w_2^*$, we have the stationary point. Consider two cases: $w_1 < w_2^*$ or $w_1 > w_2^*$.

CASE I: $w_1 < w_2^*$. The inequality (**??**) guarantees that for any wage level w_3, the equilibrium interest rate r_3 will be lower than the rate r_2 in the previous period, since we observe an increase in the wage parameter. This corresponds to the shift of the CM-line downwards. The locus of the LM-line stays unchanged (Fig. **??**). The resulting new equilibrium $\{r_3^*, w_3^*\}$ has the property $r_3^* < r_2^*, w_3^* > w_2^*$. In general, if $w_t^* < w_{t+1}^*$ then $w_{t+1}^* < w_{t+2}^*$ and $r_{t+1}^* > r_{t+2}^*$

CASE II: $w_1 > w_2^*$. Now inequality (**??**) ensures the shift of the CM-line upwards. The same reasoning as in case (I) applies. In general, if $w_t^* > w_{t+1}^*$ then $w_{t+1}^* > w_{t+2}^*$ and $r_{t+1}^* < r_{t+2}^*$.

Note that both the existence of an equilibrium and the assumption of the impossibility of corner solutions guarantee that neither interest rate r_{t+1}, nor wage rate w_{t+1} are zero or infinite in equilibrium. Hence, the sequence $\left\{r_{t+1}^*, w_{t+1}^*\right\}$ is bounded. Given any w_1, this sequence is monotonic (either increasing or decreasing in w_{t+1}). Any bounded monotonic sequence converges to a finite limit. This limit is the stationary point. ■

Chapter 5
Banks versus Markets in Processing a Macroeconomic Shock

The chapter is focused on a comparison of bank-based and market-based financial systems with respect to smoothing of the negative consequences of a macroeconomic shock. I first discuss the shock and analyze the model in presence of the production shock. Afterwards, I extend the concept of the shock in order to encompass other macroeconomic shocks. The principal finding is that the market-based system provides better arrangements to speed up the recovery after a shock, but concentrates the burden of the shock in one period. Alternatively, the bank-based system enables the negative consequences of the shock to be postponed and smoothed over several periods. However, proper regulation and interventions are needed, otherwise the banking system can collapse. As an example of regulatory interventions, liquidity provisions and deposit rate ceiling are considered.

5.1 Production Shock

In the previous chapter, it has been shown that both market-based and bank-based economies posses a stationary steady state. The steady state is independent of the initial wage endowment of the first generation as soon as the endowment is positive. The steady state is also stable, so that the system recovers to a steady state equilibrium after any deviation from it. I briefly discussed possible regulatory and institutional arrangements, which lead to the dynamic equivalence of the market economy and the intermediated one in the end of Chapter

4. In this chapter, I pay attention to the situation, in which the dynamic equivalence of both economies does not hold.

I use the steady state as a starting point for the following part of the analysis. An introduction of a shock leads to a deviation from the steady state, and hence the study of the shock's influence is partly a study of the system's stability. A recovery can hence be understood as a return of the system to the steady state after such shock-induced deviation. The number of periods, within which the system returns to the steady state, characterizes therefore the speed of recovery.

Until now there was no difference in the dynamics between market-based and bank-based economies. Partially this was due to the nature of the deviation considered (I considered only an exogenous change in the wage level as the driving force of the dynamics). Partially this was due to the institutional arrangements, which led to the identity between the financial balance-sheets of both systems. This chapter studies how differently the two economies react to the exogenous shock, if the financial balance-sheets are not identical anymore.

Surprisingly, there is no precise definition of a macroeconomic shock in the economic literature. Conventional wisdom (or common knowledge) defines economic shock as an unexpected or unpredictable event that affects an economy. More commonly, economics deals with technology shocks, which are events that change a production function in macroeconomic models. Technology shocks are permanent and mostly considered to be positive (see e.g. Galí, 2004, for some discussion). In contrast to technology shocks, production (or productivity) shocks can be negative. Another common type of shock in economics is a supply shock, which can be a consequence of a technology shock (and then the supply shock is mostly positive) or not (most negative supply shocks are not technology-driven and are not necessarily productivity-driven).

In a static (one-period or two-period) framework there is no need to distinguish between permanent and non-permanent (temporary) shocks. In a dynamic framework permanent and non-permanent shocks can lead to different implications for macroeconomic parameters (see e.g. Hall, 1988). Another issue with respect to shocks in a dynamic framework is the necessity to distinguish between the shock impact (instantaneous effects of the shock) and the subsequent effects (some discussion can be found in de Jong and Penzer, 1998).

I will take the shock to be a sharp unexpected temporary change in a macroeconomic parameter. Equivalently, one can understand under the shock a sharp temporary deviation of actual values of the macroeconomic variables from their expected values. The word "sharp" distinguishes the shock from usual expectation errors. If a change of the macroeconomic parameter may be expected, economic agents would count for it in their objective functions in expected terms. The shock differs from such expected changes in that it is not taken into account in the decision-making by agents.[45]

Below, I consider the same macroeconomic environment as in the previous chapter. First, I consider a production shock and study the degrees of shock, which are relevant for the analysis. Then I extend the nature of the shock, focusing on the study of relevant degrees of shock.

5.1.1 Shock Parameter

A **production shock** is defined as an unexpected decrease in production in some period, which, for notational convenience, I denote with $t+1$. Let the actual output in period $t+1$ be $\widetilde{f}_{t+1}$. A shock parameter q_{t+1} can be introduced as a ratio between the actual and the planned output:

$$q_{t+1} = \frac{\widetilde{f}_{t+1}}{f\left(k_{t+1}, l_{t+1}\right)}$$

Note that $q_{t+1} > 0$. Note as well that values of q_{t+1} greater than one correspond to a positive production shock. I focus here on negative temporary shocks and therefore assume $q_{t+1} \in [0, 1]$.

Furthermore, I assume that the shock is unpredictable (which is consistent with the common understanding of shocks in the literature) and happens just once over the history (the shock is temporary). If the shock has its impact in period $\tau + 1$, the distribution of the shock parameter in time can be written as

$$q_{t+1} = \begin{cases} 1 & \text{if } t \neq \tau \\ q^* < 1 & \text{if } t = \tau \end{cases} \tag{5.1}$$

Denote $p = \Pr\left(q_{t+1} = 1\right)$. The probability distribution of the shock is

$$q_{t+1} = \begin{cases} 1 & p = 1 - \varepsilon \\ q^* < 1 & (1-p) = \varepsilon \end{cases} \tag{5.2}$$

45 Particularly, the shock is not present in the profit margin of banks.

with infinitesimal ε. To follow the notation from Chapters 2 and 3, one might wish to denote the state of nature with $q_{t+1} = 1$ as "H"-state, and the state of nature with $q^* < 1$ as "L"-state. If the state of nature is "L", then the profit of an entrepreneur is

$$E_{t+1}^L = \max\left[q^* f\left(k_{t+1}, l_{t+1}\right) - \left(1 + r_{t+1}\right)\left(k_{t+1} - s_t^E\right) - w_{t+1} l_{t+1}, 0\right]$$

For the case his revenue is not high enough to cover the expenditures, there exists a priority of payments: the workers have the highest priority, the creditors have lower priority, and the entrepreneur himself has the lowest priority. Agents with higher priority are repaid before the agents with lower priority. Hence, the total wage expenditures of each entrepreneur are either wage payoffs at the rate w_{t+1} to l_{t+1} employees[46], or the whole amount of goods produced if it does not exceed the total wage payoffs due:

$$e_{t+1} = \min\left[w_{t+1} l_{t+1}, q^* f\left(k_{t+1}, l_{t+1}\right)\right] \tag{5.3}$$

The payoff of an individual entrepreneur to his creditors is then either the due payoff determined by the amount $k_{t+1} - s_t^E$ of external funds employed at the interest rate r_{t+1}, or the rest of the production deduced with the wage expenditures:

$$b_{t+1} = \min\left[\left(1 + r_{t+1}\right)\left(k_{t+1} - s_t^E\right), q^* f\left(k_{t+1}, l_{t+1}\right) - e_{t+1}\right] \tag{5.4}$$

In Chapters 2 and 3, I analyzed an economy with a risky asset (risky production technology), which yields different returns in two different states of nature. The general equilibrium OLG model in Chapter 4 is risk-free. An introduction of a shock into the model may be viewed as an introduction of a risky asset, which yields $r_{t+1}^H = r_{t+1}$ in the "H"-state of nature, and $r_{t+1}^L = \frac{q^* f(k_{t+1}, l_{t+1}) - e_{t+1}}{k_{t+1} - s_t^E} - 1$ in the "L"-state of nature. The probability $(1 - p)$ of the "L"-state of nature is determined by the probability ε of the shock.

5.1.2 Degrees of Shock

Given the priority of payments, one can distinguish between four degrees of shock:

(1) SMALL SHOCK, which leaves entrepreneurs able to meet their obligations both in wages and credit repayments. In this case $q^* \in [\overline{q}, 1]$ where $\overline{q}$ provides the equality between the actual output $\overline{q} f\left(k_{t+1}, l_{t+1}\right)$ and the production costs $\left(1 + r_{t+1}\right)\left(k_{t+1} - s_t^E\right) + w_{t+1} l_{t+1}$.

46 l_{t+1} is the individual labor demand of an entrepreneur.

This is the lowest level of disturbance, which still makes it possible for the entrepreneurs to pay out their debts $\left(k_{t+1} - s_t^E\right)$ and interest on them, as well as to completely pay out the workers' wage. The profit obtained by the entrepreneurs is below the planned level and can be zero. Wage payments are $e_{t+1} = w_{t+1}l_{t+1}$ and debt repayments $b_{t+1} = (1 + r_{t+1})\left(k_{t+1} - s_t^E\right)$ from each entrepreneur.

(2) MIDDLE-SIZED SHOCK, which still allows entrepreneurs to meet their obligations with respect to wages, but does not allow to repay debts and interest on them in full. $q^* \in \left[\underline{q}, \overline{q}\right)$ where $\overline{q}$ is the lowest small disturbance as above, and $\underline{q}$ provides $\underline{q}f\left(k_{t+1}, l_{t+1}\right) = w_{t+1}l_{t+1}$. The worst consequence of this type of shock is that the creditors receive nothing (if $q^* = \underline{q}$) but all wages are still fully paid. Payoff to workers from each entrepreneur is hence $e_{t+1} = w_{t+1}l_{t+1}$, and debt repayment is $b_{t+1} = q^* f\left(k_{t+1t}, l_{t+1}\right) - w_{t+1}l_{t+1}$. This term is always positive since $q^* f\left(k_{t+1}, l_{t+1}\right) > w_{t+1}l_{t+1}$.

(3) SEVERE SHOCK $q^* \in \left(0, \underline{q}\right)$, which not only makes entrepreneurs unable to meet their obligations with respect to their debts, bur also influences the level of wage payments to workers. Debt repayments are in this case zero $b_{t+1} = 0$, and the wage payments are $e_{t+1} = q^* f\left(k_{t+1}, l_{t+1}\right)$

(4) EXTREME SHOCK $q^* = 0$ corresponds to a complete destruction of the production facilities. Entrepreneurs have zero revenue, wage payment and credit repayment is zero.

The shock in the model is determined by the shock parameter $q^* \in [0; 1]$, and is measured by the output after the shock as a percentage of the output in steady state. This does not, however, mean that the shock of q^*, which is middle-sized or severe in one economy, would be necessarily middle-sized or severe in another economy. The severity of the shock depends on the current prices, namely on wage and interest rate level, which occur in steady state, preceding the shock. As it can be seen from the definition of the shock limits $\overline{q}$ and $\underline{q}$, they are determined by the price system in the steady state. Hence, the same shock of q^* may appear to be middle-sized in one price system, small in another price system, and severe in a third price system.

The lower limit of the small shock is

$$\overline{q} = \frac{(1 + \overline{r})\left(\overline{k} - \overline{s}^E\right) + \overline{w}\overline{l}}{f\left(\overline{k}, \overline{l}\right)} \tag{5.5}$$

and the lower limit of the middle-sized shock is

$$\underline{q} = \frac{\overline{w}\overline{l}}{f\left(\overline{k}, \overline{l}\right)} \tag{5.6}$$

with the "hatted" variables referring to the steady state (before the shock occurs).

As it can be seen, an economy with higher share of capital in production has necessarily a smaller $\underline{q}$, and hence is less vulnerable with respect to a shock: the probability that a shock of q^* is middle-sized, but not severe, is in highly capitalized economies higher than in less capitalized economies. Indeed, the ratio $\frac{f\left(\overline{k}, \overline{l}\right)}{\overline{l}}$ is the average productivity of labor $APL\left(\overline{k}, \overline{l}\right)$, which increases as the capitalization of production increases. In the stationary point, the wage level should be equal to the marginal product of labor $\overline{w} = MPL\left(\overline{k}, \overline{l}\right)$, otherwise the assumption of the profit-maximizing behavior of firms is violated. Hence, equation (**??**) may be written in a form

$$\underline{q} = \frac{MPL\left(\overline{k}, \overline{l}\right)}{APL\left(\overline{k}, \overline{l}\right)}$$

On the one hand, the higher the average productivity of labor, the smaller the interval $\left(0, \underline{q}\right)$, which determines the area of severe shocks. On the other hand, higher capitalization leads to a higher marginal product of labor, so that the general effect may be ambiguous and depends on the substitutability between labor and capital.[47]

Equation (**??**) may be reformulated as

$$\overline{q} = \frac{\left(1 + \overline{r}\right)\left(\overline{k} - \overline{s}^E\right)}{f\left(\overline{k}, \overline{l}\right)} + \underline{q}$$

so that the term $\frac{(1+\overline{r})\left(\overline{k}-\overline{s}^E\right)}{f\left(\overline{k}, \overline{l}\right)}$ indicates the length of the interval $\left[\underline{q}, \overline{q}\right)$ of the middle-sized shock. Note that $\overline{s}^E$ is the internal finance provided by entrepreneurs themselves, and $\overline{k} - \overline{s}^E$ is external borrowing. The higher the share of internal capital, the higher the probability of the shock being small. Vice versa, the higher the share of the external capital, the more vulnerable is the economy to the production shock. The above reasoning also applies to the average productivity of the borrowed capital $APK_B = \frac{f\left(\overline{k}, \overline{l}\right)}{\overline{k}-\overline{s}^E}$ and to the marginal productiv-

47 For a Cobb-Douglas production function $f = k^\alpha l^\beta$ ($\alpha + \beta \leq 1$) one obtains $APL = \frac{f}{l} = k^\alpha l^{\beta-1}$ and $MPL = \beta k^\alpha l^{\beta-1}$, so that $\underline{q} = \beta < 1$. If capital and labor are perfect substitutes ($f = \alpha k + \beta l$), $MPL = \beta$, and $\underline{q} = \frac{1}{\alpha k/l+\beta}$, which decreases with an increase in capitalization.

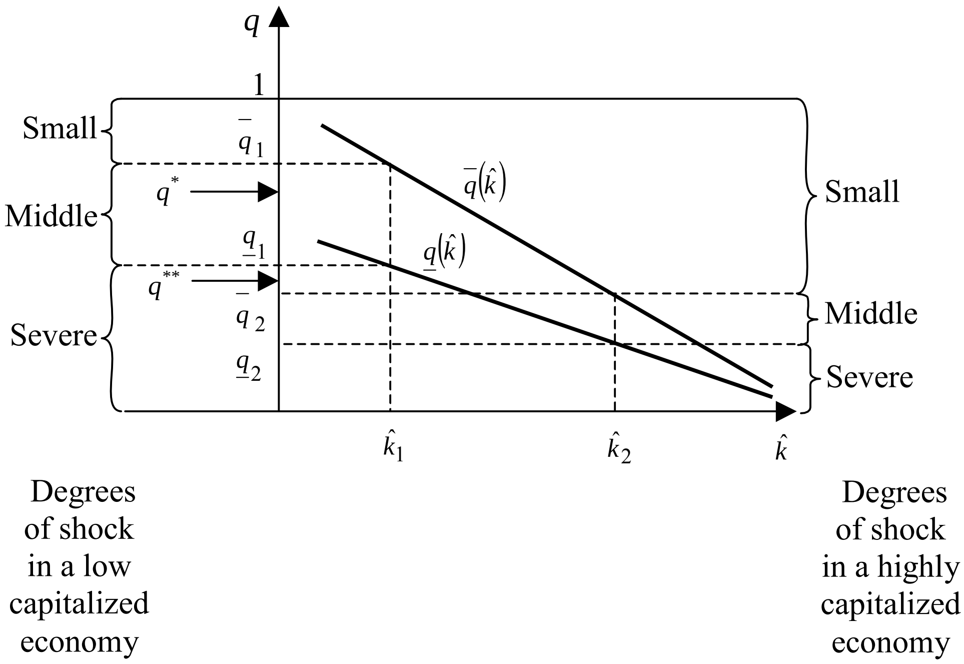

Figure 5.1. Degrees of Shock

ity of capital $MPK = 1 + \overline{r}$:

$$\overline{q} - \underline{q} = \frac{MPK\left(\overline{k}, \overline{l}\right)}{APK_B\left(\overline{k}, \overline{l}\right)}$$

One may expect that in economies with high capitalization and low costs of capital (due to decreasing marginal productivity, high capitalization implies low MPK and therefore low equilibrium borrowing costs), the difference $\overline{q} - \underline{q}$ shrinks.

If one assumes that both $\overline{q}$ and $\overline{q} - \underline{q}$ are decreasing functions of $\overline{k}$, the following schematic representation is possible (see Fig. **??**).[48] In the figure, it is shown that a shock q^* may be seen as a middle-sized shock for a smaller economy, whereas it is a small shock for a large (highly capitalized) economy. Moreover, it is also possible that a shock, which is small for a highly developed economy (q^{**}), is severe for a less developed economy.[49] This implies that e.g. a loss of 10% GDP (the shock parameter $q^* = 0.9$) may represent a small shock for a developed economy, but be a middle-sized (or even severe) shock for an underdeveloped

48 The purpose of the diagram is only to illustrate the possibility of different treatment of the same shock by different economies. A detailed analysis of the shock-response functions is not the focus of this dissertation.

49 Here, the development is understood in sense of the marginal product - average product ratios introduced above. I do not focus on this issue further, since the degree of the development is not the principal issue in the analysis here. Still, it is important to note that the relevance of the analysis *may* be different for different economies.

labor-intense economy with low average productivity of labor. This discussion suggests that the results of the current chapter may be of different significance for developed and underdeveloped economies.

5.2 Market Economy Exposed To the Production Shock

The model in the current chapter differs from the one in Chapter 4 in that there is formally some degree of risk introduced now into the economy. This implies some changes in the analysis.

5.2.1 Decision-Making and Equilibrium

Optimization problem of workers under certainty is described in Chapter 4:

$$\max_{c_t, c_{t+1}, s_t^W} u\left(c_t, c_{t+1}\right) \tag{5.7}$$

$$\begin{aligned} c_t &= w_t - s_t^W \\ c_{t+1} &= \left(1 + r_{t+1}\right) s_t^W \end{aligned}$$

Now there are two states of nature possible in each period $t+1$: one with $q_{t+1} = 1$, and one with $q_{t+1} = q^* < 1$. Depending on the state of nature, and on the shock parameter q^*, the credit repayment may be less than $\left(1 + r_{t+1}\right) s_t^W$. If the actual credit repayment b_{t+1} of an individual agent is less than the planned one, the agent experiences a deficit.

Definition 5.1 **Deficit** of an individual creditor in period $t+1$ is

$$d_{t+1}^W = \frac{1-\eta}{\eta} b_{t+1} - \left(1 + r_{t+1}\right) s_t^W$$

Aggregate deficit in the economy in period $t+1$ is hence

$$d_{t+1} = (1-\eta)\, b_{t+1} - \eta \left(1 + r_{t+1}\right) s_t^W$$

Remember that b_{t+1} is a total repayment of an individual entrepreneur to his creditors. In total, repayments from all entrepreneurs (who are identical) are $(1-\eta)\, b_{t+1}$. Since these repayments are equally distributed among all the creditors, each creditor obtains $\frac{1-\eta}{\eta} b_{t+1}$ as the credit repayment. From the definition of b_{t+1} in the shock description (**??**) it follows that if each entrepreneur is able to meet his obligations in full, he repays exactly

$(1+r_{t+1})\left(k_{t+1}-s_t^E\right)$, which implies a repayment to each individual creditor in an amount of $\frac{1-\eta}{\eta}(1+r_{t+1})\left(k_{t+1}-s_t^E\right)$. If a creditor is repaid in full, he receives $(1+r_{t+1})\,s_t^W$, and hence the two expressions are equal:

$$\frac{1-\eta}{\eta}(1+r_{t+1})\left(k_{t+1}-s_t^E\right)=(1+r_{t+1})\,s_t^W$$

If the entrepreneurs are not able to repay on their debts in full, each creditor obtains $\frac{1-\eta}{\eta}b_{t+1}<(1+r_{t+1})\,s_t^W$, which implies for the deficit of the creditor $d_{t+1}\leq 0$.

Assume now that the preferences of workers with regard to the outcomes in both states of nature are given by a von Neumann-Morgenstern utility function. Denote actual (realized) wage income of each member of the young generation t with $\widehat{w}_t=\frac{e_t}{l_t}$. Then the expected utility maximization problem of the workers of this generation is given by

$$\begin{aligned}U\left(c_t,c_{t+1}^H,c_{t+1}^L\right) &= pu\left(c_t,c_{t+1}^H\right)+(1-p)\,u\left(c_t,c_{t+1}^L\right)\to\max_{c_t,c_{t+1}^H,c_{t+1}^L,s_t^W} \qquad (5.8)\\ \text{s.t.}\ \ c_t &= \widehat{w}_t-s_t^W\\ c_{t+1}^H &= (1+r_{t+1})\,s_t^W\\ c_{t+1}^L &= (1+r_{t+1})\,s_t^W+d_{t+1}^W\end{aligned}$$

with $c_{t+1}^{\mathbf{s}_{t+1}}$ denoting the consumption of workers in case no shock occurs ($\mathbf{s}_{t+1}=H$) or in case if the shock occurs ($\mathbf{s}_{t+1}=L$). Given the probability distribution of the shock (**??**), it is easy to see that the optimization problem (**??**) is equivalent to (**??**) in the limit. The savings function of workers (depositors) is hence the same as previously

$$s_t^W=s^W\left(\widehat{w}_t,r_{t+1}\right) \qquad (5.9)$$

The same considerations apply to the entrepreneurs (see also explanations on the production and profit functions above). Hence, the optimization problem of the entrepreneurs is effectively the same as before

$$\begin{aligned}&\max_{c_t,c_{t+1},s_t^E} u\left(c_t,c_{t+1}\right) \qquad (5.10)\\ c_t &= \widehat{w}_t-s_t^E\\ c_{t+1} &= E_{t+1}^e\left(s_t^E,w_{t+1},r_{t+1}\right)\end{aligned}$$

with the notation from the previous chapter.

The expected profit of entrepreneurs is given by

$$E^{e}_{t+1} = pE^{H}_{t+1} + (1-p)\, E^{L}_{t+1} \tag{5.11}$$

Due to the probability distribution p, expected profit of the entrepreneurs

$$E^{e}_{t+1} \to f\left(k_{t+1}, l_{t+1}\right) - \left(1 + r_{t+1}\right)\left(k_{t+1} - s^{E}_{t}\right) - w_{t+1} l_{t+1}$$

Profit maximization problem repeats the one described in the previous chapter in the absence of the shock.

The savings function of the entrepreneurs is again given by

$$s^{E}_{t} = s^{E}\left(\widehat{w}_{t}, w_{t+1}, r_{t+1}\right) \tag{5.12}$$

Note that I use here the assumption of perfect foresight with regard to the future wage rate $w^{e}_{t+1} = w_{t+1}$. This does not contradict to the inability of agents to predict the shock. Indeed, perfect foresight regarding future wage rate means that the agents can estimate the *future* equilibrium wage rate on the basis of their *current* knowledge.

Note as well that the wage rate w_{t+1}, which is set by the entrepreneurs of the generation t for period $t+1$, is not necessarily equal to the actual wage payments $\widehat{w}_{t+1}$ to generation $t+1$. After the shock, the actual wage payment may be lower then the one planned. This will then influence the equilibrium in the next period as a parameter, but must not be the equilibrium wage rate.

Definition 5.2 A **temporary equilibrium with perfect foresight (TEPF)** in the shock-exposed market economy in period $t \geq 1$ under the parameters $\{\widehat{w}_{t}, q_{t+1}\}$ is an array of the price vector $\left\{r^{*}_{t+1}, w^{*}_{t+1}, \widehat{w}_{t+1}\right\}$ and of the allocation vector $\left\{k^{*}_{t+1}, l^{*}_{t+1}, s^{E*}_{t}, s^{W*}_{t}, d^{W}_{t+1}\right\}$, which for a given q_{t+1} provides that

(1) $(1-\eta)\left(k_{t+1} - s^{E}_{t}\right) = \eta s^{W}_{t}$

(2) $(1-\eta)\, l_{t+1} = 1$

(3) $d^{W}_{t+1} = \frac{1-\eta}{\eta} b_{t+1} - \left(1 + r_{t+1}\right) s^{W}_{t}$

with $b_{t+1} = \min\left[\left(1 + r_{t+1}\right)\left(k_{t+1} - s^{E}_{t}\right), q_{t+1} f\left(k_{t+1}, l_{t+1}\right) - e_{t+1}\right]$

and $e_{t+1} = \min\left[w_{t+1} l_{t+1}, q_{t+1} f\left(k_{t+1}, l_{t+1}\right)\right]$

(4) $\widehat{w}_{t+1} = \min\left[w_{t+1}, \frac{q_{t+1} f\left(k_{t+1}, l_{t+1}\right)}{l_{t+1}}\right]$

The first two equations in the definition of equilibrium are the conditions of credit and labor market clearing. The third condition determines the level of deficits. The last equation determines the actual wage earnings of the young generation.

Note that the TEPF of period $t+1$ is not conditioned on the level of deficits d_t^W. This is the distinctive property of the **market** economy: the equilibrium in period $t+1$ does not depend on the level of deficits in period t. The level of deficits d_t^W is only relevant for the level of consumption of the old workers in period t, but not for the future equilibria.

5.2.2 Evolution Before the Shock

If $t < \tau$, the shock parameter q_t is always $q_t = 1$. Hence the deficit level is always zero. Proposition 4.6 from Chapter 4 applies. The economy settles in the stationary equilibrium with some stationary wage level $\overline{w}$ and zero deficits in the banks. This equilibrium is stationary until the shock occurs.

5.2.3 Evolution After the Shock

Consider now the evolution of the economy after the shock $q_t = q^* < 1$, i.e. for $t \geq \tau$. If the shock is small, $q^* \in [\overline{q}, 1]$, entrepreneurs are able to meet their obligations with respect to wages and debt repayments in period τ. Next period starts with the same equilibrium as before the shock, so that the stationary persists. There is no need to further analyze this case.

If the shock is middle-sized, i.e. $q^* \in \left[\underline{q}, \overline{q}\right)$, the entrepreneurs are able to cover their obligations with respect to wages, but are not able to repay their debts to the creditors in full. The creditors (old workers) experience in this case deficits

$$d_{\tau+1}^W = \frac{1-\eta}{\eta}\left(q^* f\left(k_\tau, l_\tau\right) - w_\tau l_\tau\right) - \left(1+r_\tau\right) s_\tau^W < 0$$

Change in deficits (d^W falls from $d_\tau^W = 0$ to some $d_{\tau+1}^W < 0$) does not change anything in equilibrium, since the old workers do not participate in the clearing of the credit market. The only generation, which suffers from the shock, is the old generation. The young agents clear credit and labor markets so that the stationary equilibrium persists.

The case of a severe shock $q^* \in \left(0, \underline{q}\right)$ differs from the above in that the initial change in deficits is bigger (since creditors receive nothing from the entrepreneurs), and the wages to the young generation cannot be repaid in full. The savings of the young generation

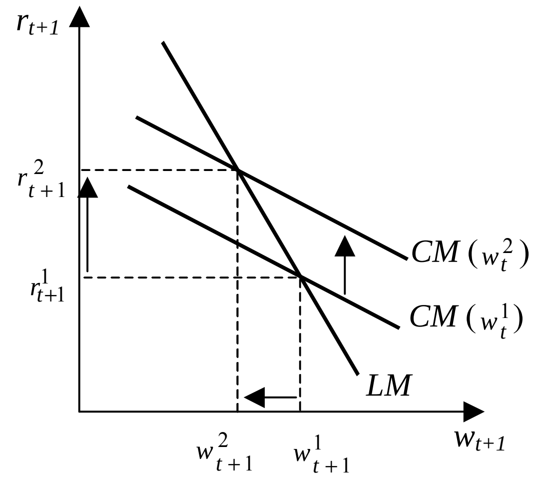

Figure 5.2. Change in the TEPF in response to a fall in wage payments after a shock.

$s^W_{\tau+1}$ are smaller than those of the previous generation s^W_τ due to $E_\tau < (1-\eta)\, w_\tau l_\tau = (1-\eta)\, w_{\tau-1} l_{\tau-1}$. This causes CM-line to shift upwards (for any new wage level credit market clears with a higher interest rate, see Fig. **??** and Appendix 4.A to Chapter 4), so that the change in general equilibrium is given by the slope of the LM-line, and the equilibrium wage level $w^*_{\tau+2}$ is lower than $w^*_{\tau+1} = w^*_\tau$. Along with that, the equilibrium interest rate increases from r^*_τ to $r^*_{\tau+1}$. In Figure **??**, it is shown with the shift of an equilibrium price system from $\left(w^1_{t+1}, r^1_{t+1}\right)$ to $\left(w^2_{t+1}, r^2_{t+1}\right)$ caused by a decrease of the actual wage payment from w^1_t to w^2_t. Since the clearing of the credit market does not involve old workers, the deficit is not transferred to the next period:

$$d^W_{\tau+n+1} = (1-\eta)\,(1+r_{\tau+n+1})\left(k_{\tau+n+1} - s^E_{\tau+n}\right) - \eta\,(1+r_{\tau+n+1})\, s^W_{\tau+n} = 0 \qquad (5.13)$$

which is valid for any $n \in \mathbb{N}$. Again, the Proposition 4.6 from Chapter 4 applies. The economy recovers to the stationary steady state, as soon as $q^* > 0$. Otherwise the economy collapses in the shock period: neither the old nor the young generation have any funds. The existence of the equilibrium is violated, since the level of savings is zero due to zero wage payments, however the level of credit demand is strictly positive.

5.3 Intermediated Economy Exposed To the Production Shock

Consider now the model with financial intermediation as in the previous chapter. Financial intermediation is again presented in the economy through banks, which collect savings from workers in form of deposits, and offer credits to entrepreneurs in order to finance their demand for credits, given by the excess of the optimal capital level for their production technology over the accumulated entrepreneurial savings.

5.3.1 Decision-Making and Equilibrium

Decision-making repeats that of the market economy, so that the savings functions and the demand for production factors are the same. The only difference, which appear now, concerns the distinction between the credit and deposit markets. The savings function of the entrepreneurs and their demand for production factors in period t depend now on the credit interest rate r_{t+1}^C

$$\begin{aligned} s_t^E &= s^E\left(\widehat{w}_t, w_{t+1}, r_{t+1}^C\right) \\ k_{t+1} &= k\left(r_{t+1}^C, w_{t+1}\right) \\ l_{t+1} &= l\left(r_{t+1}^C, w_{t+1}\right) \end{aligned}$$

The savings function of the workers depends on the deposit interest rate:

$$s_t^W = s^W\left(\widehat{w}_t, r_{t+1}^D\right)$$

In period t, the entrepreneurs require credit from banks in amount needed to finance their investment demand. Within period $t+1$, all entrepreneurs repay to the banks $B_{t+1} = (1-\eta)\, b_{t+1}$ with

$$b_{t+1} = \min\left[\left(1+r_{t+1}\right)\left(k_{t+1}-s_t^E\right), q_{t+1} f\left(k_{t+1}, l_{t+1}\right) - e_{t+1}\right]$$

and

$$e_{t+1} = \min\left[w_{t+1} l_{t+1}, q_{t+1} f\left(k_{t+1}, l_{t+1}\right)\right]$$

If in period $t+1$ the total payoff B_{t+1} of entrepreneurs to banks does not cover total obligations of banks before their depositors, banks experience deficits.

Definition 5.3 **Deficit** in the banking system in period $t+1$ is

$$d_{t+1} = (1-\eta)\, b_{t+1} - \eta \left(1 + r_{t+1}^{D}\right) s_t^W < 0 \tag{5.14}$$

According to this definition, if banks acquire from their borrowers in period $t+1$ an amount $(1-\eta)\, b_{t+1} < \eta \left(1 + r_{t+1}^{D}\right) s_t^W$, their deficit d_{t+1} consitutes $(1-\eta)\, b_{t+1} - \eta \left(1 + r_{t+1}^{D}\right) s_t^W$. Banks start period $t+1$ with this deficit. If in some period $d_{t+1} > 0$, it is called banks' surplus.

Under a perfect competition in the banking sector, we obtain in any period t the equality between the credit and the deposit interest rates $r_t^D = r_t^C = r_t$, as in Chapter 4.

Definition 5.4 A **temporary equilibrium with perfect foresight (TEPF)** in the shock-exposed intermediated economy in period $t \geq 1$ under the parameters $\{\widehat{w}_t, d_t, q_{t+1}\}$ is an array of the price vector $\left\{r_{t+1}^{C*}, r_{t+1}^{D*}, w_{t+1}^{*}, \widehat{w}_{t+1}\right\}$ and of the allocation vector $\left\{k_{t+1}^{*}, l_{t+1}^{*}, s_t^{E*}, s_t^{W*}, d_{t+1}\right\}$, which for a given q_{t+1} provides that

(1) $(1-\eta)\left(k_{t+1} - s_t^E\right) = \eta s_t^W + d_t$

(2) $(1-\eta)\, l_{t+1} = 1$

(3) $d_{t+1} = (1-\eta)\, b_{t+1} - \eta\left(1 + r_{t+1}\right) s_t^W$
with $b_{t+1} = \min\left[\left(1 + r_{t+1}\right)\left(k_{t+1} - s_t^E\right), q_{t+1} f\left(k_{t+1}, l_{t+1}\right) - e_{t+1}\right]$
and $e_{t+1} = \min\left[w_{t+1} l_{t+1}, q_{t+1} f\left(k_{t+1}, l_{t+1}\right)\right]$

(4) $\widehat{w}_{t+1} = \min\left[w_{t+1}, \frac{q_{t+1} f(k_{t+1}, l_{t+1})}{l_{t+1}}\right]$

(5) $r_{t+1}^{C} = r_{t+1}^{D} = r_{t+1}$

The last condition is the competitive outcome for credit and deposit interest rates, like in Gersbach and Wenzelburger (2002 a), see a discussion of this condition in Appendix **??**. The link between the deposit and the credit market is given by the balance sheet equation of the banks (condition 1 in Definition **??**). There is neither credit nor deposit rationing in the banking system, hence the total amount of deposits with banks is equal to the total savings of the workers ηs_t^W, and the amount of credits granted by banks is equal to the total amount of credit resources $(1-\eta)\left(k_{t+1} - s_t^E\right)$ demanded by the entrepreneurs.

Now the TEPF of period $t+1$ is parametrized on d_t, since the [aggregate] deficit of period t is transferred through the banks into the credit market, where the entrepreneurs borrow for investment into the production of period $t+1$. Compare this with Definition **??** of the equilibrium in the market economy exposed to a shock. The difference in condition 1 in both definitions is the crucial difference between the two economies.

Note also, that changes in the deficit level influence only the CM-line, and do not influence the LM-line, although the equilibrium would differ for different values of d_t. An increase in deficits (or equivalently decrease in surplus, i.e. d_t falls) increases equilibrium interest rate as defined by the credit market for any wage level w_{t+1} so that CM-line shifts upwards in (w_{t+1}, r_{t+1})-plane (straightforward from the equilibrium condition for the credit market):

$$\frac{\partial r_t^{CM}}{\partial d_t} < 0 \tag{5.15}$$

Proposition 5.1 *The equilibrium interest rate and the equilibrium wage level depend on the deficits in the banking sector so that the equilibrium interest rate increases and the equilibrium wage level decreases if the deficits deteriorate:*

$$\frac{\partial r_t^*}{\partial d_t} < 0; \frac{\partial w_{t+1}^*}{\partial d_t} > 0 \tag{5.16}$$

The intuition behind this Proposition is obvious. According to (**??**) and due to the independence of the labor market equilibrium of the deficits in banking system, the equilibrium interest rate and the wage level are determined by the movement of the equilibrium point along the LM-line, as shown in Figure **??**. Since the slope of the CM-line can be either negative or positive (but never smaller than the slope of the LM-line), both cases are presented in the diagram.

5.3.2 Evolution Before the Shock

If $t < \tau$, the shock parameter is always $q_{t+1} = 1$. The economy sets in the equilibrium with zero deficits in the banks, as in the shockless case in the previous chapter. This equilibrium is stationary.

The system of equilibrium conditions for the credit and the labor market together with the definition of deficits (**??**) determines a dynamic system with respect to w and d: $\Phi\left(w_t, d_t\right) \rightarrow$

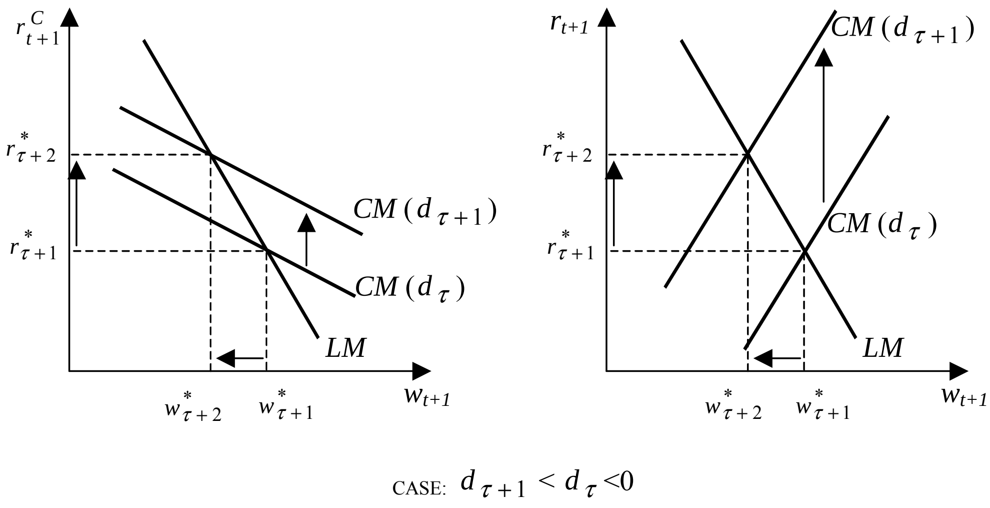

Figure 5.3. Effect of the change in banks deficits on the equilibrium.

(w_{t+1}, d_{t+1}) with map $\Phi\,(w_t, d_t)$ given implicitly by the system

$$\Phi\,(w_t, d_t) : \begin{cases} (1-\eta)l_{t+1} = 1 \\ (1-\eta)\left(k_{t+1} - s^E_t\right) = \eta s^W_t + d_t \\ d_{t+1} = (1-\eta)(1+r^C_{t+1})\left(k_{t+1} - s^E_t\right) - \eta(1+r^D_{t+1})s^W_t \\ k_{t+1} = k(r^C_{t+1}, w_{t+1}) \\ l_{t+1} = l(r^C_{t+1}, w_{t+1}) \\ s^E_t = s^E\left(w_t, w_{t+1}, r^C_{t+1}\right) \\ s^W_t = s^W\left(w_t, r^D_{t+1}\right) \\ r^C_{t+1} = r^D_{t+1} \end{cases} \tag{5.17}$$

Note that since the shock parameter is always $q_{t+1} = 1$, borrowers are always able to pay wages to the workers in full, hence $e_{t+1} = w_{t+1}l_{t+1}$. Moreover, they are always able to repay their debts in full, hence $b_{t+1} = (1+r^C_{t+1})\left(k_{t+1} - s^E_t\right)$. This implies the equation for deficits d_{t+1} in the map (**??**) above

Proposition 5.2 *Dynamic system (**??**) has a steady state (stationary) with $d = 0$ and $w = \overline{w}$, which does not depend on initial conditions.*

Proposition **??**, in contrast to Proposition 4.7 from Chapter 4, establishes the existence of the steady state in an economy, where the banking system may transfer deficits from one period to another. Note that Proposition **??** does not guarantee the stability of the steady state. This implies that if the economy starts with zero deficits in the banking system and there are no shocks, the economy converges to a steady state, as given by Proposition 4.7 in Chapter 4. The following section studies the question of the evolution of the economy, if the banking system experiences deficits after the shock.

5.3.3 Evolution After the Shock

Consider now the evolution of the economy after the shock $q^* < 1$, i.e. for $t \geq \tau$. The map $\Phi\left(\widehat{w}_t, d_t\right) \rightarrow \left(\widehat{w}_{t+1}, d_{t+1}\right)$ is now changed:

$$\Phi\left(\widehat{w}_t, d_t\right): \begin{cases} (1-\eta)l_{t+1} = 1 \\ (1-\eta)\left(k_{t+1} - s_t^E\right) = \eta s_t^W + d_t \\ d_{t+1} = (1-\eta)b_{t+1} - \eta(1+r_{t+1}^D)s_t^W \\ b_{t+1} = \min\left[(1+r_{t+1})\left(k_{t+1} - s_t^E\right), q_{t+1}f\left(k_{t+1}, l_{t+1}\right) - e_{t+1}\right] \\ e_{t+1} = \min\left[w_{t+1}l_{t+1}, q_{t+1}f\left(k_{t+1}, l_{t+1}\right)\right] \\ \widehat{w}_{t+1} = \frac{e_{t+1}}{l_{t+1}} \\ k_{t+1} = k(r_{t+1}^C, w_{t+1}) \\ l_{t+1} = l(r_{t+1}^C, w_{t+1}) \\ s_t^E = s^E\left(w_t, w_{t+1}, r_{t+1}^C\right) \\ s_t^W = s^W\left(w_t, r_{t+1}^D\right) \\ r_{t+1}^C = r_{t+1}^D = r_{t+1} \end{cases} \tag{5.18}$$

Note that the map $\Phi\left(\widehat{w}_t, d_t\right)$ shows how the parameters $\widehat{w}_t$ and d_t of the system change over time, given an exogenous control parameter q_{t+1}.

(1) SMALL SHOCK: the profit of the entrepreneurs is

$$E_{\tau+1} = q^* f\left(k_{\tau+1}, l_{\tau+1}\right) - \left(1 + r_{\tau+1}^c\right)\left(k_{\tau+1} - s_\tau^E\right) - w_{\tau+1}l_{\tau+1} \geq 0$$

The wage expenditures of each entrepreneur are $e_{\tau+1} = w_{\tau+1}l_{\tau+1}$, and his credit repayments are $\left(1 + r_{\tau+1}^C\right)\left(k_{\tau+1} - s_\tau^E\right)$, which implies for the aggregate credit repayments

$$(1-\eta)\, b_{\tau+1} = (1-\eta)\left(1 + r_{\tau+1}^C\right)\left(k_{\tau+1} - s_\tau^E\right)$$

New wage parameter for the next period is $\widehat{w}_{\tau+1} = w_{\tau+1}$, and the deficit level in the banking system is $d_{\tau+1} = 0$. The stationary equilibrium persists.

(2) MIDDLE-SIZED SHOCK: the profit of the entrepreneurs is $E_{\tau+1} = 0$. The wage expenditures of each entrepreneur are $e_{\tau+1} = w_{\tau+1}l_{\tau+1}$, therefore his aggregate credit repayments are

$$(1-\eta)\, b_{\tau+1} = (1-\eta)\left[q^* f\left(k_{\tau+1}, l_{\tau+1}\right) - w_{\tau+1}l_{\tau+1}\right]$$

The deficit level in the banking system is

$$d_{\tau+1} = (1-\eta)\left[q^* f\left(k_{\tau+1}, l_{\tau+1}\right) - w_{\tau+1} l_{\tau+1}\right] - \eta\left(1 + r^D_{\tau+1}\right) s^W_\tau < 0$$

Change in deficits shifts the CM-line in Fig. **??** upwards, and the equilibrium wage level $w_{\tau+2}$ is lower than $w_{\tau+1} = w_\tau$; along with that equilibrium interest rate increases from r_τ to $r_{\tau+1}$. No new shocks and no changes in the behavior of agents occur. From this point on $\widehat{w}_{\tau+1} = w_{\tau+1}$. Further dynamics of deficits in banks is given by

$$d_{\tau+n+1} = (1-\eta)\left(1 + r^C_{\tau+n+1}\right)\left(k_{\tau+n+1} - s^E_{\tau+n}\right) - \eta\left(1 + r^D_{\tau+n+1}\right) s^D_{\tau+n} \tag{5.19}$$

Since the credit market is in equilibrium, and since $r^C_{\tau+n+1} = r^D_{\tau+n+1} = r^*_{\tau+n+1}$ due to the competition in the banking sector, we obtain

$$d_{\tau+n+1} = \left(1 + r^*_{\tau+n+1}\right) d_{\tau+n} \tag{5.20}$$

which is valid for any $n \in \mathbb{N}$. As soon as $r^*_{\tau+n} > 0$, deficits in banks deteriorate until the banking system is bankrupt, i.e. $d_{\tau+n} = \underline{d_{\tau+n}} \leq -\eta s^W_{\tau+n}$. This last condition means that the newly accumulated deposits cannot provide the system with credit resources after covering deficits in the banking system. No new credits can be granted, and hence banks obtain zero credit repayment at the end of the period, and cannot meet their obligations with respect to deposits anymore.

(3) SEVERE SHOCK: profit of the entrepreneurs is $E_{\tau+1} = 0$. Wage expenditures of each entrepreneur are $e_{\tau+1} = q^* f\left(k_{\tau+1}, l_{\tau+1}\right)$, credit repayment is $(1-\eta)\, b_{\tau+1} = 0$. The deficit level in the banking system is $d_{\tau+1} = -\eta\left(1 + r^D_{\tau+1}\right) s^W_\tau < 0$. Since newly acquired deposits $s^W_{\tau+1}$ are smaller in amount than s^W_τ (since the actual wage repayment $\widehat{w}_{\tau+1} = \frac{q^* f(k_{\tau+1}, l_{\tau+1})}{l_{\tau+1}}$ is smaller than the wage level $w_{\tau+1}$), banking system is bankrupt[50]: $d_{\tau+1} = -\eta\left(1 + r^D_{\tau+1}\right) s^W_\tau < -\eta s^W_{\tau+1} = \underline{d_{\tau+1}}$

(4) EXTREME SHOCK: the economy collapses in the period of the shock.

The four scenarios above differ in the degree of the initial production shock heating the economy. The regulatory forbearance may lead to no harmful effects if the shock is small. If the shock is middle-sized and leads to defaults on credits, the banks experience deficits, and effectively borrow from the next generations to cover the deficits. The competition in the

[50] Again, this holds under a positive interest rate.

banking sector implies then that the costs of borrowing are excessively high for the banks, and the amount of deficits increases from period to period. This leads to a collapse of the banking system, which is not able anymore to repay the deposits. If the shock is severe, the collapse happens in the first period after the shock.

Corollary 5.1 *Intermediated economy with long-lived competitive banks and workout incentives of the future generations under a regime of regulatory forbearance may experience a collapse of the banking system in a finite number of periods.*

Compare the four scenarios above with the discussion of the degrees of the shock in Section **??**. This sheds some light on the difference between the effects of the forbearance policy in countries with different vulnerability to the shock. As I indicated in Section **??**, an explanation of such a difference may lie in the different capitalization of production technologies. Developed countries are less likely to suffer from the negative effects of the regulatory forbearance, since these are revealed only if the shock is middle-sized or severe. In contrast, the policy of regulatory forbearance may be harmful for less developed economies, since these are more likely to be hit with a shock of a middle or even severe degree.

The result also underlines the role of the competition in the banking sector. Indeed, if the competition is not intense, banks are able to exploit positive profit margin, which they could use to cover the deficits. I will return to the role of the profit margin later on, when I introduce a regulatory intervention in the model.

5.4 Payment Shock

So far, it has been assumed that the macroeconomic shock is on the production side. Now relax this assumption. The analysis above shows that the principal effect of the shock is a deterioration of the balance sheets of the banks in case of intermediated economy, or an underpayment to creditors in the case of market economy. If the shock is small, no deficits appear, and this case is not relevant for the analysis, since no changes in the dynamics of events occur. If the shock is middle-sized, deficits arise. If the shock is severe, wage underpayment occurs in addition to the deficits in the market economy, whereas the intermediated economy collapses. In the case of the extreme shock, both market and intermediated economies collapse in the period of shock.

Note that if the collapse of the intermediated economy in the case of a severe shock could be prevented (e.g. through liquidity assistance), the further development of events would be the same as in the case of a middle-sized shock, though deteriorated by smaller equilibrium wage levels in the periods subsequent to the shock. The reaction of the system to a wage underpayment is considered in the previous chapter, where the existence and stability of the stationary state was studied. In the absence of deficits, wage shock would lead to a recovery, since the stationary steady state in the model without deficits is stable. Hence, of most relevance for the analysis is the reaction of the system to a change in deficits. The mechanism, how the deficits occur, is irrelevant. This is the main intuition behind shifting the shock directly to the balance sheets (either of banks or of the creditors).

5.4.1 Description of the Payment Shock

A payment shock appears as a change in deficits, which fall from the zero point to some negative level. This can be seen as if there exists a transaction (payment) system, which unexpectedly induces transaction costs of the iceberg type: a certain fraction of the payment is lost *after* a debtor has repaid his debt, but *before* a creditor has received the payment. In a world with money and nominal prices this could be possible, or example, due to a sharp inflation, when a repayment is made nominally in the full amount, but is smaller in real terms.

Another variation of the shock is considered in Appendix **??**. In that case, the shock is on the demand side: entrepreneurs expect a technological breakthrough and therefore demand more capital and labor. However such expectations turn out to be false, and there is no increase in production. As a result, banks (or creditors) are underpaid, they experience a deficit, but there is no fall in production, exactly as in the case of the payment shock.

I will consider below the case of the payment shock, for it seems to be a generalization of all other types of non-permanent (temporary) shocks, whose impact is the occurrence of the deficits without any change in other variables. Remember that the impact of the shock should be distinguished from the subsequent events (*after-shock*), which can (and do) include changes in other macroeconomic variables.

In terms of the degrees of the shock, the payment shock corresponds to the middle-sized production shock. The reason for this is the condition that only deficits may occur as the direct impact of the shock. Hence, the payment shock cannot directly change the wage repayments to the workers, which is the distinguishing line between the middle-sized shock and the severe one.

5.4.2 Market Economy Exposed to a Payment Shock

Return for a moment to the definition of deficits which may arise after the production shock in the market economy:

$$\begin{aligned} d_{t+1} &= (1-\eta)\, b_{t+1} - \eta\,(1+r_{t+1})\, s_t^W \\ \text{with } b_{t+1} &= \min\left[(1+r_{t+1})\left(k_{t+1}-s_t^E\right), q_{t+1} f\left(k_{t+1}, l_{t+1}\right) - e_{t+1}\right] \\ \text{and } e_{t+1} &= \min\left[w_{t+1} l_{t+1}, q_{t+1} f\left(k_{t+1}, l_{t+1}\right)\right] \end{aligned}$$

By definition, the payment shock leads to an occurrence of deficits in the system, therefore it does not cover the case of a small production shock. Again, by definition, the deficit is the only impact of the payment shock, and hence no fall in production is possible, and the wage payment to each worker is always equal to the equilibrium wage rate. Hence, the payment shock mostly corresponds to the case of the middle-sized production shock. In this case, the credit repayment is always $b_{t+1} = (1+r_{t+1})\left(k_{t+1}-s_t^E\right)$ (individually from each entrepreneur). Each creditor is supposed to obtain a share $\frac{1-\eta}{\eta}$ of this repayment (remember, η is the share of creditors, and $1-\eta$ is the share of entrepreneurs in the economy).

Using the metaphor of the iceberg-type transaction costs we can assume that each creditor receives only a fraction q_{t+1} of his/her repayment, and therefore experiences a deficit

$$d_{t+1}^W = q_{t+1}\left[\frac{1-\eta}{\eta}(1+r_{t+1})\left(k_{t+1}-s_t^E\right)\right] - (1+r_{t+1})\, s_t^W$$

The aggregate deficit of all creditors is therefore

$$d_{t+1} = q_{t+1}(1-\eta)(1+r_{t+1})\left(k_{t+1}-s_t^E\right) - \eta\,(1+r_{t+1})\, s_t^W$$

Now call this *new* q_{t+1} the shock parameter and assume it has the same distribution in time and the same probability distribution as the production shock parameter from before.

Definition 5.5 In the market economy exposed to a payment shock, a **temporary equilib-**

rium with perfect foresight (TEPF) in period $t \geq 1$ under the parameters $\{w_t, q_{t+1}\}$ is an array of the price vector $\left\{r^*_{t+1}, w^*_{t+1}\right\}$ and of the allocation vector $\left\{k^*_{t+1}, l^*_{t+1}, s^{E*}_t, s^{W*}_t, d_{t+1}\right\}$, which provides that

(1) $(1-\eta)\left(k_{t+1} - s^E_t\right) = \eta s^W_t$

(2) $(1-\eta)\, l_{t+1} = 1$

(3) $d_{t+1} = q_{t+1}\,(1-\eta)\,(1+r_{t+1})\left(k_{t+1} - s^E_t\right) - \eta\,(1+r_{t+1})\, s^W_t$

The equilibrium condition for the credit market lets us reformulate the deficit in the following way:

Definition 5.6 Aggregate deficit in the market economy exposed to a payment shock is given in period $t+1$ by

$$d_{t+1} = -(1-q_{t+1})\eta\,(1+r_{t+1})\, s^W_t \tag{5.21}$$

As before, the TEPF exists and is unique for any period $t \geq 1$. It is important that the shock leaves wage repayment always positive, otherwise Proposition 4.3 would not hold.

Without shocks, the equilibrium in the market economy reaches its steady state.

If the shock occurs, creditors are not repaid in full, and experience deficit $d_{t+1} < 0$. This leads to the following:

(1) Old workers, who acted as creditors, obtain smaller repayment than expected, and their consumption in the shock period is less than needed to achieve the planned utility level. The case $q^* = 0$ would leave old workers with zero consumption in the shock period.

(2) Young workers do not suffer.[51] Saving decisions of the young generation repeat those of the old one in the preceding period, so that equilibrium persists.

(3) After the shock the system stays at the steady state. Therefore, the only part of the population, which suffered from the shock, are old workers. The loss in their consumption is exactly $d_{t+1} = -(1-q^*)\eta b_t$.

It is easy to see that the development of events after a payment shock coincides with the development of events in the market economy after a middle-sized production shock.

[51] Remember, in case of the production shock it may happen that the young workers obtain reduced wage repayments, which would change their savings decisions.

Corollary 5.2 *Market-based economy recovers to the steady state within one period after the shock, leaving the burden of the shock completely on creditors of the shock period.*

5.4.3 Intermediated Economy Exposed to a Payment Shock

The intermediated economy under the payment shock differs from the market one in that the deficits (Definition **??**) are created in the banks and can be transferred into the next periods. Markets for credit and for savings are separated, but the interest rates are assumed to be equal due to the competition in the banking sector, as before.

Definition 5.7 In the intermediated economy exposed to a payment shock, a **temporary equilibrium with perfect foresight (TEPF)** in period $t \geq 1$ under parameters $\{w_t, d_t, q_{t+1}\}$ is an array of the price vector $\left\{r_{t+1}^{C*}, r_{t+1}^{D*}, w_{t+1}^*\right\}$ and of the allocation vector $\left\{k_{t+1}^*, l_{t+1}^*, s_t^{E*}, s_t^{W*}, d_{t+1}\right\}$, which provides that

(1) $(1-\eta)\left(k_{t+1} - s_t^E\right) = \eta s_t^W + d_t$

(2) $(1-\eta)\, l_{t+1} = 1$

(3) $d_{t+1} = d_t - (1-q_{t+1})\,\eta\left(1 + r_{t+1}^D\right) s_t^W$

(4) $r_{t+1}^C = r_{t+1}^D$

Consider the evolution of the economy after the shock in period τ. Banks experience deficit $d_{\tau+1} = -\left(1 - q^*\right)\eta\left(1 + r_{\tau+1}^D\right) s_\tau^W < 0$, with which they start period $\tau + 1$. The development of events repeats the one in the case of the middle-sized production shock. The impact of the payment shock is the change in deficits. The subsequent events are illustrated by the shift of the CM-line (see Fig. **??** above) upwards and include a decrease in the equilibrium wage level and an increase in the interest rates. No new shocks occur. Further dynamics of the deficits in banks is again given by

$$d_{\tau+n+1} = \left(1 + r_{\tau+n+1}^*\right) d_{\tau+n} \tag{5.22}$$

which is valid for any $n \in \mathbb{N}$. As soon as $r_{\tau+n+1}^* > 0$, the amount of deficits in banks increases until the banking system is bankrupt, i.e. there exists such $m \in \mathbb{N}$ that $d_{\tau+m} \leq \underline{d_{\tau+m}} = -\eta s_{\tau+m}^W$.

Corollary 5.3 *Intermediated economy collapses after a payment shock in a finite number of periods.*

Note that in contrast to Corollary **??**, the payment shock definitely leads to a collapse of the intermediated economy, since the case of a small shock, which provided for the no collapse case, is excluded by the definition of the payment shock.

5.5 Regulatory Interventions

The collapse of the intermediated economy after the shock underlines the need for a regulatory intervention to avoid the collapse. I will consider two possible interventions from the side of the regulator:

(1) Liquidity injections to banks

(2) Setting a deposit rate ceiling

In both cases, I assume banks to be credible institutions (possibly under guarantees of the regulator) so that the question of credibility and bank runs does not arise.

5.5.1 Liquidity Injections

Assume that the regulator possesses a stock $\overline{M}$ of liquid funds, which can only be accessed by banks experiencing deficits and is not otherwise used. This is a simplifying assumption. On the one hand, one could introduce a tax system into the model to endogenize the subsidy to the banks, as it was done in Chapter 2. On the other hand, such subsidization should not be internalized by the public (see Chapters 2 and 3). An introduction of an exogenous stock $\overline{M}$ is a kind of such subsidy, which is not internalized by the public. In an economy with money, one could see it as money printing. In my model, the economy is described in real terms, so the "liquid funds" are goods. There are several possible interpretations of the stock of liquid funds $\overline{M}$:

(1) $\overline{M}$ is lump-sum and is collected each period from workers and given back in the next period. This may induce some changes in savings-consumption decisions of the workers.

(2) $\overline{M}$ is proportional to the amount of deposits. In this case, the effective interest rate

on deposits is given by the weighted average of the announced deposit rate and on the interest rate on such proportional deduction, and the change in the analysis reduces to the change in the deposit interest rate. This interpretation is close to the concept of deposit insurance.

(3) $\overline{M}$ may be borrowed from outside of the economy. In this case the economy is open. This interpretation is close to the concept of the International Lender of Last Resort (ILOLR), the function the International Monetary Fund often performs.

(4) $\overline{M}$ is a stock of durable goods accumulated by the regulator in the steady state, and used to smoothen the deviations of the economy from the steady state. This interpretation is close to the concept of the Stabilization Fund as adopted by many central banks (e.g. Exchange Stabilization Fund of the U.S. Federal reserve) and governments (e.g. Stabilization Fund of the Russian Federation).

These four interpretations indicate possible extensions of the model to study the effects beyond the focus of the analysis here. Here, I concentrate on the impact of liquidity injections in order to study the desirability of such intervention. The question of its optimal financing is therefore out of consideration and left for a further investigation. In terms of the four interpretations above the closest one to the model is the ILOLR-intervention or the exploitation of a stabilization fund.

If deficits occur ($d_t < 0$), banks may apply for one-period credits from the Regulator charged with the interest rate r^M. This is a general formulation: setting $r^M = -1$ corresponds to the case of a subsidy. The total amount of loans granted by the Regulator in period t has to cover the deficits in the banking sector and is therefore

$$M_t = \begin{cases} -d_t, & \text{if } d_t < 0 \\ 0 & \text{if } d_t \geq 0 \end{cases} \tag{5.23}$$

Credit from the Regulator is granted in the end of period t, covers deficits accrued in period t, lasts for one period and is repaid to the Regulator at the end of period $t+1$ in total amount of $(1 + r^M)M_t$.

The equilibrium condition for the credit market changes to

$$(1 - \eta)\left(k_{t+1} - s_t^E\right) = \eta s_t^W + d_t + M_t \tag{5.24}$$

To complete the description I assume that the interest (if any) gained on such liquidity injections is used to increase the stock $\overline{M}$. I leave therefore all possible fiscal distortions (taxes and income redistribution) aside and focus only on the bailout effect of such intervention.

5.5.2 Deposit Rate Ceiling

The Regulator sets the deposit rate ceiling $r^D = r^{Dreg}$ as soon as the capital adequacy ratio is not fulfilled (surplus accumulated in the banks is smaller than a certain fraction $\alpha \in [0;1]$ of the total banking assets)[52]:

$$d_t < \alpha (1-\eta) \left(k_{t+1} - s_t^E\right) \tag{5.25}$$

In this case either credit rates are below the ceiling, so that no bank is interested in setting the deposit rate above the credit rate, and hence the situation coincides with the unregulated economy[53] with $r_{t+1}^C = r_{t+1}^D = r_{t+1}^*$; or the credit rate (the interest rate determined by the credit market) is above the ceiling, which means that the deposit rate is fixed:

$$r_{t+1}^D = \min\left(r^{Dreg}, r_{t+1}^C\right) \tag{5.26}$$

With regard to the equilibrium definition, condition (**??**) replaces condition 4 in Definition **??**.

Fixing the deposit rate means that the deposit supply of period t depends only on the wage level w_t; the deposit market is still in equilibrium (all deposits supplied are acquired by banks).

The definition of equilibrium **??** is valid for the regulated case as well. Moreover, the equilibrium condition for the labor market is not disturbed by the introduction of the regulation since it depends only on the credit interest rate:

$$(1-\eta)\, l\left(r_t^C, w_{t+1}\right) = 1 \tag{5.27}$$

The equilibrium condition for the credit market changes to

$$(1-\eta)\left(k\left(w_{t+1}, r_{t+1}^C\right) - s^E\left(w_t, w_{t+1}, r_{t+1}^C\right)\right) = \eta s^W\left(w_t, w_{t+1}, r^{Dreg}\right) + d_t \tag{5.28}$$

52 This is again a general formulation. In the economy considered in this paper surplus of the banks is zero due to competition, therefore deposit rate ceiling is introduced from the beginning.

53 For the rest of this chapter, I use the term "unregulated" to refer to the economy with neither liquidity injections nor deposit rate ceiling. Certainly, such an economy is still regulated, since the regulator decides upon the bailout policy (and chooses forbearance in this current chapter). Hence "unregulated" refers to the economy with no *additional* regulation.

so that the right-hand side does not depend on the credit interest rate anymore. Obviously, equilibrium credit rate is negatively related with regulated deposit rate, since the left-hand side negatively depends on the credit rate: $\frac{\partial r_t^C}{\partial r^{Dreg}} < 0$. This is easily explained by the fact that a decrease in the deposit rate leads to less deposits in the banks, and therefore to lower supply of credits, which become more expensive in order to hold the equilibrium. In other words, setting the regulated deposit rate at the level below that of the unregulated equilibrium, increases credit interest rate and hence makes the banks' profit margins positive (recall, in the unregulated case both rates are equal). Graphically, this corresponds to the shift of the CM-line upwards as soon as the regulated deposit interest rate is set below the equilibrium level, as depicted in Figure **??**.

5.6 Intermediated Economy: Regulated Dynamics

Assume that the economy has settled in the steady state with $d_t = 0$. Consider how the regulatory interventions described above affect the economy after the shock and whether they prevent the collapse of the economy (the bankruptcy of the banking system), which happened in the unregulated case.

5.6.1 Liquidity Injections

Assume that the payment shock creates non-zero deficits in the banking system in the period τ, so that the banking system starts period $\tau + 1$ with negative deficits $d_{\tau+1} < 0$. The credit market equilibrium condition (**??**) implies

$$(1-\eta)\left(k_{\tau+2} - s^E_{\tau+1}\right) = \eta s^W_{\tau+1} + d_{\tau+1} + M_{\tau+1} \tag{5.29}$$

Since the liquidity injection from the Regulator exactly covers the deficits, $M_{\tau+1} = -d_{\tau+1}$, the equilibrium in the credit market is unchanged, and hence the credit interest rate and the wage stay at their respective stationary levels. A further change in deficits is given now by

$$d_{\tau+2} = (1-\eta)\left(1 + r^C_{\tau+2}\right)\left(k_{\tau+2} - s^E_{\tau+1}\right) - \eta\left(1 + r^D_{\tau+2}\right) s^W_{\tau+1} - \left(1 + r^M\right) M_{\tau+1} \tag{5.30}$$

From now on, two scenarios are possible:

(1) Liquidity injection does not change (for whatever reason) profit expectations of the banks. The expected profit of the banks for period $\tau+2$ is then

$$\Pi^e_{\tau+2} = (1-\eta)\left(1+r^C_{\tau+2}\right)\left(k_{\tau+2}-s^E_{\tau+1}\right) - \eta\left(1+r^D_{\tau+2}\right)s^W_{\tau+1} = 0$$

The expected profit is equal to zero due to the competition in the banking sector. This implies together with (**??**)

$$d_{\tau+2} = -\left(1+r^M\right)M_{\tau+1} = \left(1+r^M\right)d_{\tau+1} \qquad (5.31)$$

Hence, with $r^M > 0$, deficits in the banking sector deteriorate further. The unrestricted continuation of the liquidity injections policy repeats the above described steps, and, as in the case of unregulated dynamics, the collapse is unavoidable: the banking system is bankrupt. The stock of liquid funds $\overline{M}$ can not be exhausted, since starting from the period $\tau+2$ deficits in the banking system are constituted only of the debt before the regulator, so that "liquidity" injections do not actually require the transfer of liquid funds, but rather take a form of "virtual" credits, which only result in accumulation of unpaid interest. Setting $r^M = 0$ allows the postponement of the collapse without any accumulation of debt. But in any case such forbearance policy[54] does not create any incentives for banks to repay their debt to the Regulator, since the banks expect the deficits to be continuously covered by new liquidity injections from the side of the Regulator without any restrictions, and do not account for repayments in their profit expectations.[55]

(2) Liquidity injection changes profit expectations of the banks. This happens, for example, if the banks are penalized if they do not repay the loan M duly, or if the regulator intervenes in the decision-making of the bank.[56] The expected profit of the banks for the period $\tau+2$ is then

$$\Pi^e_{\tau+2} = (1-\eta)\left(1+r^C_{\tau+2}\right)\left(k_{\tau+2}-s^E_{\tau+1}\right) - \eta\left(1+r^D_{\tau+2}\right)s^W_{\tau+1} - \left(1+r^M\right)M_{\tau+1} = 0$$

Zero expected profit (due to competition) implies that the banks set the deposit interest rate below the credit interest rate (which is fixed by the credit market equilibrium **??**) as

54 Remember, banks are formally bankrupts, since their assets are below their liabilities.

55 The case of subsidy ($r^M < 0$) would prevent the collapse but requires substantial changes in the model to meet budget constraints.

56 See the example of the Swedish banking crisis in Chapter 6, which may clarify this idea.

soon as $r^M > -1$. The new level of deficits in the banking system is then

$$d_{\tau+2} = 0$$

At the same time, the amount of deposits in the banking sector decreases due to a decrease in the deposit interest rate (hence, $s^W_{\tau+1} < s^W_\tau$) and the credit market is cleared under a higher credit interest rate for any wage level: $(1-\eta)\left(k_{\tau+2} - s^E_{\tau+1}\right) = \eta s^W_{\tau+1}$. This corresponds to the shift of the CM-line in Figure **??** upwards and the new equilibrium is achieved at the level $r^C_{\tau+2} > r^C_{\tau+1}$, $w_{\tau+2} < w_{\tau+1}$.

In period $\tau+2$ the agents determine the equilibrium of period $\tau+3$ at the steady state level since the competition implies

$$\Pi^e_{\tau+3} = (1-\eta)\left(1 + r^C_{\tau+3}\right)\left(k_{\tau+3} - s^E_{\tau+2}\right) - \eta\left(1 + r^D_{\tau+3}\right)s^W_{\tau+2} = 0$$

and therefore it implies the equality between deposit and credit interest rates $r^C_{\tau+3} = r^D_{\tau+3}$.

The discussion above leads to the following conclusions:

Corollary 5.4 *Liquidity injections after the payment shock may have different effects depending on the arrangements:*

(1) The forbearance policy of the Regulator with no punishment, either postpones the collapse (if injections are made in form of credits with zero interest rate) or prevents the collapse (in case of the subsidy). In both cases the burden of the payment shock is borne by the regulator.

(2) Short-term credits with sufficient restrictions on further access of banks to the liquid funds of the regulator shift the profit expectations of the banks and may lead to a prevention of the collapse. The burden of the payment shock is borne by the population in the period next to the shock: depositors receive deposit interest below the credit interest rate, and at the same time they obtain smaller wages due to a fall in production, which also leads to a lower consumption level of entrepreneurs.

The first part of Corollary **??** refers to the case, in which the liquidity injections do not alter the profit expectations of the banks. This is possible when banks have free access to the credit window and do not internalize the costs of the bailout, i.e. expect that the bailout is actually performed through a subsidy. One can see it as an insufficient signal from the regulator about the conditions of the bailout. The case of the pure subsidy, although allowing for a recovery, needs further investigation if a closed economy is considered. It should then be specified, how the subsidy is financed, see the discussion of the possible interpretation of the liquidity injections above (Section **??**).

Note as well that the case of liquidity injections almost completely corresponds to the case of banks borrowing from future generations. The two very principal differences are: (1) in case of liquidity injections, the interest rate r^M is not the equilibrium outcome but rather is set by the regulator, and (2) the regulator possesses some power over banks and may make banks internalize the costs of such a bailout. Both differences may relate to the regulation of the competitive structure of the banking sector.

The second part of Corollary **??** refers to the case, in which the banks internalize the costs of bailouts. The loan obtained by the banks allows them to repay old depositors in full, but shifts the burden of the shock to the next generation: banks take into account that they will have to pay back the loan, and hence they have to decrease the deposit interest rate. This induces lower savings and lower amount of deposits with the banks, which in turn leads to lower amount of funds available for bank loans, and the credit rate increases. In effect, the banks obtain the possibility to exploit a positive interest rate margin.

Again, one may see deposits from future generations as a kind of a liquidity injection. If it would be possible to make banks internalize the costs of bailout, the banking system would recover similarly to the case of the liquidity injection above. Still, a regulatory intervention would be necessary to force the banks to follow decisions which are not necessarily a competitive equilibrium outcome. Particularly this refers to the creation of an interest rate margin $r^C_{\tau+2} - r^D_{\tau+2} > 0$, which allows the deficits to be covered. If the competition is intense, each bank would have an incentive to reduce the interest rate margin through setting a higher deposit rate, which may increase the overall profit even under a smaller interest rate margin. This is why the banking system cannot recover without proper regulation.

The idea of the interest rate margin is closely related to the second type of the regulatory intervention, which I consider below.

5.6.2 Deposit Rate Ceiling

If the banking system starts with zero deficits, intervention rule (**??**) is fulfilled, and regulation is introduced from the beginning. If $r^{Dreg} > r^C$, the deposit interest rate will be equal to the credit interest rate $r^C = r^D = r^*$ so that the regulated dynamics repeats the case of the unregulated one. After the shock, the credit interest rate increases, as shown for the case of the unregulated dynamics, and at some point the condition $r^{Dreg} < r^C$ will hold, so that the deposit rate is fixed by the regulation[57].

Assume that this happens in period $t = \tau$, so that $r^D_{\tau+n} = r^{Dreg}$ (at least for some first $n \in \mathbb{N}$). The dynamics of the deficits in the banks is then given by

$$d_{\tau+n+1} = (1-\eta)\left(1 + r^C_{\tau+n+1}\right)\left(k_{\tau+n+1} - s^E_{\tau+n}\right) - \eta\left(1 + r^{Dreg}\right) s^W_{\tau+n} \tag{5.32}$$

Due to $r^{Dreg} < r^C$ and the credit market equilibrium condition (see Definition **??**) we obtain

$$d_{\tau+n+1} = \left(1 + r^C_{\tau+n+1}\right) d_{\tau+n} + \eta\left(r^C_{\tau+n+1} - r^{Dreg}\right) s^W_{\tau+n} \tag{5.33}$$

To provide a reduction in deficits, i.e. $d_{\tau+n+1} > d_{\tau+n}$, it is necessary that

$$r^{Dreg} < r^C_{\tau+n+1}\left(1 + \frac{d_{\tau+n}}{\eta s^W_{\tau+n}}\right) < r^C_{\tau+n+1} \tag{5.34}$$

The simplest way to meet this criterion is to set $r^{Dreg} = 0$. Such a sharp measure is however only needed if the system falls close to bankruptcy, i.e. when $d_{\tau+n} \to -\eta s^W_{\tau+n}$. In all other cases this criterion can be met with strictly positive values of the deposit rate ceiling. Since the equilibrium credit interest rate increases with a deterioration of bank deficits, the deposit rate ceiling can be established at the level of the stationary credit interest rate, observed in the economy before the shock: $r^{Dreg} = r^C\big|_{d=0}$.

Corollary 5.5 *An economy with an appropriately chosen (in sense of inequality* **??***) deposit rate ceiling recovers after the shock to a steady state with $d = 0$.*

Note that the introduction of the deposit rate ceiling endogenizes the bailout, in contrast to the liquidity injections above. The main feature of the deposit rate ceiling is the creation of a positive profit margin for the banks, which would allow them to cover deficits. The same effect would also be achieved with a loan from the regulator charged with the interest rate r^M if the regulator could make banks internalize the costs of the bailout and create an interest rate margin. Both the loan and the deposit rate ceiling distort the competitive outcome in the

57 Of course if the deposit rate ceiling is not set too high: $r^{Dreg} < r^{crit}$ where $r^{crit} = \arg\left[d_t = -\eta s^D_t\left(\cdot, r^{crit}\right)\right]$, i.e. critical value of the market interest rate, when the banking system is bankrupt, and no further development occurs.

banking sector with regard to the relationship between the credit interest rate and the deposit interest rate.

5.7 Welfare Considerations

As the above analysis shows, macroeconomic evolution after a sharp macroeconomic shock depends on the structure of the financial system and on the degree of the shock.

In the following comparison, I will consider the social losses of the period of shock impact, i.e. the losses in consumption of all the agents, who live in the period, when the shock first causes changes in the equilibrium. Hence, the considerations here concern the shock impact and not the subsequent events. The analysis in this chapter shows that the market economy does not generate subsequent events after the shock. This is true for the small and middle-sized production shocks as well as for the payment shock. In the case of a severe production shock, there are subsequent events, which are generated by the shock and transferred in the market economy to further after-shock periods. Obviously, the scale of these subsequent events is not greater than the scale of the same events in the intermediated economy (since deficits, which are generated in the banking system, create an additional obstacle for the system to recover). Therefore one can expect that the market economy, which demonstrates higher speed of recovery, would overperform the intermediated economy in sense of smaller consumption losses for the generations *after* the shock. The question is hence, whether market economy performs better or worse than the intermediated one in the period of the shock impact? Below I show that the social losses for the generations, who live in this period, are smaller in the case of the intermediated economy. In terms of an intertemporal social welfare function, there always exists such a function which would attribute smaller intertemporal social losses to an intermediated economy (it suffices to count for the losses of future generations with a high enough discount factor). At the same time there always exist social welfare functions, which would attribute better performance (in sense of intergenerational reduction of social losses) to the market economy.

In the discussion of degrees of production shock, I have already mentioned that the severity of the shock crucially depends on the development of production technology and on the price system. The shock, which would be small for a developed economy, can appear to be middle-sized for an underdeveloped economy. Since the issue of poverty reduction in underdeveloped economies is of great importance, a system, which would prevent disproportion in social losses over generations, could be desirable. Welfare considerations below demonstrate that an intermediated financial system provides such mechanism of loss reduction in the period of shock.

I assume that the shock q^* happens in period t after the system has settled in its steady state. I consider first the production shock, as it has additional impact, namely a decrease in production in the shock period. The payment shock corresponds in large to the middle-sized production shock, but induces no decrease in production as a direct impact.

5.7.1 Small Production Shock

In both systems only one group of agents suffers from the shock: namely, the entrepreneurs of generation τ suffer from lower consumption when old.

Social losses are

$$\Delta_{\tau+1}^{M} = \Delta_{\tau+1}^{I} = (1-\eta)\left(c_{\tau+1}^{E} - q^{*} f\left(k_{\tau+1}, l_{\tau+1}\right)\right)$$

Consumption of the entrepreneurs $c_{\tau+1}^{E}$ is $c_{\tau+1}^{E} = f\left(k_{\tau+1}, l_{\tau+1}\right) - \left(1 + r_{\tau+1}\right)\left(k_{\tau+1} - s_{\tau}^{E}\right) - w_{\tau+1} l_{\tau+1}$, so that

$$\Delta_{\tau+1}^{M} = \Delta_{\tau+1}^{I} = (1-\eta)\left(\left(1-q^{*}\right) f\left(k_{\tau+1}, l_{\tau+1}\right) - \left(1+r_{\tau+1}\right)\left(k_{\tau+1} - s_{\tau}^{E}\right) - w_{\tau+1} l_{\tau+1}\right)$$

and the difference in social losses of the first period is zero:

$$\Delta_{\tau+1}^{M} - \Delta_{\tau+1}^{I} = 0$$

5.7.2 Middle-Sized Production Shock

Recall that a middle-sized shock is determined by $q^* \in \left[\underline{q}, \overline{q}\right)$ where $\overline{q}$ is defined as

$$\overline{q} = \frac{(1+\widehat{r})\left(\widehat{k} - \widehat{s}^{E}\right) + \widehat{w}\widehat{l}}{f\left(\widehat{k}, \widehat{l}\right)}$$

and $\underline{q}$ is defined as

$$\underline{q} = \frac{\widehat{w}\widehat{l}}{f\left(\widehat{k}, \widehat{l}\right)}$$

(1) **Market economy.** Entrepreneurs of generation τ are bankrupts, and their consumption in this period is zero, so that their losses equal to planned consumption $f\left(k_{\tau+1}, l_{\tau+1}\right) - \left(1+r_{\tau+1}\right)\left(k_{\tau+1} - s_{\tau}^{E}\right) - w_{\tau+1} l_{\tau+1}$. Creditors (old workers) of generation τ suffer from the insufficient loan repayments $\left(1+r_{\tau+1}\right)\left(k_{\tau+1} - s_{\tau}^{E}\right) - q^{*} f\left(k_{\tau+1}, l_{\tau+1}\right)$. Young generation receives their wage payment in full and does not suffer from the shock. Social losses are in this case

$$\begin{aligned}\Delta_{\tau+1}^{M} &= (1-\eta)\left(f\left(k_{\tau+1}, l_{\tau+1}\right) - \left(1+r_{\tau+1}\right)\left(k_{\tau+1} - s_{\tau}^{E}\right) - w_{\tau+1} l_{\tau+1}\right) + \\ &\quad + \eta\left(\left(1+r_{\tau+1}\right)\left(k_{\tau+1} - s_{\tau}^{E}\right) - q^{*} f\left(k_{\tau+1}, l_{\tau+1}\right)\right)\end{aligned}$$

(2) **Intermediated economy.** Entrepreneurs of generation τ are bankrupts and their consumption is zero. Banks experience deficits, but manage to repay all debts to depositors, so that no losses on the side of depositors occur. Social losses in period $\tau+1$ are

$$\Delta_{\tau+1}^{I} = (1-\eta)\left(f\left(k_{\tau+1}, l_{\tau+1}\right) - \left(1+r_{\tau+1}\right)\left(k_{\tau+1} - s_{\tau}^{E}\right) - w_{\tau+1} l_{\tau+1}\right)$$

There are indirect losses associated with the increase in credit interest rate and decrease both in deposit interest rate and wage level, so that few next generations can not enjoy from consumption at the steady state level. But no other direct social losses occur in the shock period. With due regulation economy recovers to the stationary state.

Comparing both cases, we obtain:

$$\Delta_{\tau+1}^{M} - \Delta_{\tau+1}^{I} = \eta\left(\left(1+r_{\tau+1}\right)\left(k_{\tau+1} - s_{\tau}^{E}\right) - q^{*} f\left(k_{\tau+1}, l_{\tau+1}\right)\right) > 0$$

5.7.3 Severe Production Shock

Severe shock is determined by $q^{*} \in \left[0, \underline{q}\right)$ with $\underline{q}$ as above.

(1) **Market economy.** Entrepreneurs of generation τ are again bankrupts with zero consumption. Creditors (old workers) of generation τ receive zero loan repayments and their individual losses amount to $\left(1+r_{\tau+1}\right) s_{\tau}^{W}$. The young generation receives reduced wage repayments and their losses are $w_{\tau+1} l_{\tau+1} - q^{*} f\left(k_{\tau+1}, l_{\tau+1}\right)$. Total social losses are

in this case

$$\begin{aligned}\Delta_{\tau+1}^{M} &= (1-\eta)\left(f\left(k_{\tau+1},l_{\tau+1}\right)-\left(1+r_{\tau+1}\right)\left(k_{\tau+1}-s_{\tau}^{E}\right)-w_{\tau+1}l_{\tau+1}\right)+ \\ &+\eta\left(1+r_{\tau+1}\right)s_{\tau}^{W}+w_{\tau+1}l_{\tau+1}-q^{*}f\left(k_{\tau+1},l_{\tau+1}\right)\end{aligned}$$

(2) **Intermediated economy.** As in case of market economy, entrepreneurs of generation τ are bankrupts, and the young generation receives reduced wage repayments. Along with that, the banking system is bankrupt, since banks receive zero loan repayment, so that it produces the same result as in case of market economy.

$$\Delta_{\tau+1}^{M}-\Delta_{\tau+1}^{I}=0$$

5.7.4 Payment Shock

Payment shock resembles the middle-sized production shock with the exception that the entrepreneurs of the shock period do not suffer, since there is no loss in production

(1) **Market economy.** Creditors (old workers) of generation τ suffer from the insufficient consumption due to deficits $d_{\tau+1}=-(1-q_{\tau+1})\eta\left(1+r_{\tau+1}\right)s_{\tau}^{W}$. Young generation receives their wage payment in full and does not suffer from the shock. Total social losses are in this case

$$\Delta_{\tau+1}^{M}=(1-q_{\tau+1})\eta\left(1+r_{\tau+1}\right)s_{\tau}^{W}$$

(2) **Intermediated economy.** Banks experience deficits, but use the newly made deposits to repay all debts to depositors of the previous generation. Social losses in period τ are

$$\Delta_{\tau+1}^{I}=0$$

Comparing both cases yields:

$$\Delta_{\tau+1}^{M}-\Delta_{\tau+1}^{I}=(1-q_{\tau+1})\eta\left(1+r_{\tau+1}\right)s_{\tau}^{W}>0$$

Corollary 5.6 *In the case of a middle-sized production shock and in the case of a payment shock, the social losses in an intermediated economy in the period of the shock are smaller than in the market one. Other types of shock lead to equal social losses in the period of the shock in both economies.*

Note again that this result describes only the impact of the shock, not the subsequent events. In the periods subsequent to the period of the shock, the market economy may outperform the intermediated one. The overall performance of an economy may only be judged upon a comparison of the dynamic losses, i.e. the losses of all generations in all periods after the shock. This would require a welfare metric (social welfare indicator) and a social discount factor to compute an intertemporal social welfare function. The following example explains why the overall result crucially depends on the choice of the intertemporal social welfare function.

Assume that the intertemporal social welfare function implies the following social losses function (with superscript I denoting the intermediated economy; symmetric for the market economy):

$$\Xi^I = \sum_{n=1}^{\infty} \xi_{\tau+n} \Delta^I_{\tau+n}$$

with τ denoting the period of the shock, $\xi_{\tau+n}$ - a weight coefficient, and $\Delta^I_{\tau+n}$ social losses of period $\tau + n$ computed as the difference between the social welfare in the steady state and the actual social welfare.

If we choose $\xi_\tau = 1$ and $\xi_{\tau+n} = 0$ for all $n \geq 1$, we obtain the case of no intergenerational altruism, which would attribute better performance to the intermediated economy, since it outperforms the market economy in the period of the shock. If we choose $\xi_{\tau+n} = 0$ for all $1 \leq n \leq m$, and $\xi_{\tau+n} = 1$ for all $n \geq m + 1$, we obtain the case of an extreme intergenerational altruism, where the generation τ cares only about the welfare of their ancestors of degrees m and higher. In this case it would be possible to find such m that the social losses function attributes better performance to the market economy, since the market economy possesses a higher speed of convergence to the steady state.

Considerations in this Section show that it is not a trivial task to judge upon which system provides better arrangements against macroeconomic shocks. The judgment would crucially depend on the choice of the social welfare function. Still, as Bolton(2002) notes, the question of which type of financial system should be adopted, is of a great relevance for transitory and developing countries. One may expect that for a country in poverty and with high vulnerability to shocks it may be desirable to provide the arrangements, which would rather guarantee a smoothening of the shock impact over several generations than a high speed of recovery with high burden on one generation. In this sense, the current chapter suggests that a properly regulated banking system may provide such arrangements. However, it may be necessary for a system of deposit insurance or state guarantees on deposits to exist. Such a system is needed to prevent bank runs and to allow banks to borrow from the next generations.

5.8 Summary

A market-based financial system provides quicker recovery of the economy after a non-permanent negative shock such as a production shock or a payment shock. A bank-based financial system in absence of proper regulation leads to a collapse of the economy after such a shock. A regulatory measure should provide banks with the opportunity to exploit positive profit margin, which is used to cover the deficits, which occur after the shock. Liquidity assistance does not accelerate the recovery, but rather postpones the collapse, if it is not a subsidy-type assistance or an assistance which forces banks to create the interest rate margin. In an economy with a properly regulated banking system the recovery is in general slower than in the market economy.

However, the market economy concentrates the burden of the shock in one period (with the exception for a severe production shock). In contrast, bank-based financial systems smoothen the shock, so that the burden of the shock for the generations in the period of the shock impact is reduced. At the same time, subsequent generations suffer from reduced consumption due to lower wages and higher interest rates in the economy. The banking system demonstrates therefore the capacity to smoothen the shock over time through redistribution of it over several generations.

It should be noted that further *after-shock* generations do not experience a decrease in consumption compared to their consumption plans; their planned consumption is always achieved in equilibrium. The reduction in consumption is revealed only through a comparison with a benchmark case, which is a steady state level ("golden path").

In the case of a production shock, different degrees of it should be distinguished. Countries with more labor-intensive production seem to be more vulnerable to stronger shocks, whereas developed countries seem to be less vulnerable to the degrees of the shock, which may demonstrate the difference between the market-based and bank-based financial systems. This qualitative remark may be another fact in favor of establishing bank-oriented financial systems in emerging economies, due to their smaller capitalization and poorer technological development. On the contrary, in developed economies the probability of middle-sized shocks is lower, and the advantages of the banking system in intertemporal smoothing of exogenous negative shocks may be less noticeable.

The concept of a payment shock in this chapter allows to extend the results for the types of shock which appear not at the production side. Examples of such shocks may be government defaults, a liquidity crisis in the banking system, a stock exchange crash, or a devaluation of the local currency. The common feature of these shocks is that they create deficits in the banking system, and the impact of the shock is then spread in the economy through the banking system. In the next chapter, I discuss the development of events in Russia in the aftermath of the Default of the Government of the Russian Federation in August 1998.

Appendix 5.A

Deposit Interest Rate under Perfect Competition in the Banking Sector

In the following, I use the notation from the text of the chapter.

Consider a competitive banking system in period t. Since the banking system is assumed to consist of a continuum of banks, and due to homogeneity of banks, the balance sheet of an individual bank, and the size of its deficit are the same as for the whole banking system. The balance sheet of an arbitrary bank, which experiences a deficit d_t, is given by

$$I_t = D_t + d_t \tag{5.A.1}$$

with I_t = the total amount invested in the credit market (and in the equilibrium in the credit market it should hold $I_t = (1-\eta)\left(k_{t+1} - s_t^E\right)$), and D_t = the total amount of deposits acquired by the bank (and in the equilibrium in the deposit market it should hold $D = \eta s_t^W$).

The bank maximizes its expected profit

$$\begin{aligned}
\Pi_{t+1}^e &= I_t\left(1+r_{t+1}^C\right) - D_t\left(1+r_{t+1}^D\right) \rightarrow \max_{I,D} \\
\text{s.t. } I_t &= D_t + d_t \\
\text{and } \Pi_{t+1}^e &\geq d_t\left(1+r_{t+1}^C\right)
\end{aligned} \tag{5.A.2}$$

The first constraint is the balance sheet equation, and the second constraint describes the outcome, which the bank may obtain without entering the competition game in the deposit market. Usually, it is assumed that if the bank does not enter the market, it's profit is zero, and hence a standard assumption on the "no-entry" outcome is $\Pi_{t+1}^e \geq 0$. In case of deficits, the bank starts period t with deficit $d_t < 0$, which is exogenously given for period t.

Theoretically, the "no-entry" option may result in the liquidation of the bank, since it is bankrupt. Indeed, if the bank does not entry the market, it collects no deposits, and has no funds to pay the amount $|d_t|$ to depositors, and hence (partially) defaults on its obligations. If the liquidation option is cost-less (the bank does not internalize the costs of liquidation), the bank faces the constraint $\Pi_{t+1}^e \geq 0$, which leads to the following deposit demand function of an individual bank (the aggregate deposit demand function is the same due to the unit mass of the banking sector):

$$D^d \in \begin{cases} \{0\} & \text{if } r^D_{t+1} \geq r^C_{t+1} \\ \{\infty\} & \text{if } r^D_{t+1} < r^C_{t+1} \end{cases}$$

Since the deposit supply $D^s = \eta s^W_t$ is non-zero and bounded from above, no equilibrium in the deposit market exists. This is an additional argument in favor of the internalization of the liquidation costs by the bank, besides those discussed in Chapter 2.

Since no internalization is harmful, I assume the bank faces costs of liquidation, say in the form of a penalty on the shareholders of the bank in amount of $d_t\left(1 + r^C_{t+1}\right)$. Another explanation could be that in a hope for a turnaround the bank may opt to wait one period (which is possible due to the forbearance policy as soon as the bank is able to repay its debts to the depositors) and borrows d_t at the interbank market at the rate r^C_{t+1}. This also implies the costs of the "no-entry" option in amount of $d_t\left(1 + r^C_{t+1}\right)$. This explains the second constraint in the maximization problem (**??**).

Substituting for (**??**) into (**??**) and finding the first derivative with respect to D_t yields

$$\frac{\partial \Pi^e_{t+1}}{\partial D_t} = r^C_{t+1} - r^D_{t+1}$$

If $r^C_{t+1} > r^D_{t+1}$, the bank's demand for deposits in infinite, if $r^C_{t+1} < r^D_{t+1}$, the bank's demand for deposits is zero since otherwise the expected profit is below $d_t\left(1 + r^C_{t+1}\right)$. Finally, if the interest rates are equal, the bank is indifferent with respect to the amount of deposits:

$$D^d \in \begin{cases} \{0\} & \text{if } r^D_{t+1} > r^C_{t+1} \\ [0, \infty) & \text{if } r^D_{t+1} = r^C_{t+1} \\ \{\infty\} & \text{if } r^D_{t+1} < r^C_{t+1} \end{cases}$$

Since the supply of deposits is non-zero and finite, the equilibrium in the deposit market is only possible if $r^D_{t+1} = r^C_{t+1}$.

Appendix 5.B

Variation of the Macroeconomic Shock

So far, I have assumed that the economy suffers from macroeconomic shock q_{t+1}, which influences the deficits of the banks in period $t+1$.

The only endogenous source of a change in deficits could be an insufficient repayment from entrepreneurs to the banks: if the shock $q^* < 1$ is realized in period τ, the repayments

$$b_{\tau+1} < \left(1 + r^C_{\tau+1}\right)\left(k_{\tau+1} - s^E_\tau\right) \tag{5.B.1}$$

I assume the shock to be exogenously given and to influence the ability of borrowers (entrepreneurs) to pay out the debts. In the case of production shock, entrepreneurs are the first who suffer from shock due to priority of payments: first workers, then banks, and the rest goes to the entrepreneurs. Now I assume that entrepreneurs have possibility to default on their obligations to banks.

One possible explanation for this would be that the shock does not influence production directly, but influences the decision-making of entrepreneurs who overestimate their expected profits in a following way (written for an arbitrary period t):[58]

$$E^e_{t+1} = \frac{1}{q_{t+1}} f\left(k_{t+1}, l_{t+1}\right) - \left(1 + r^C_{t+1}\right)\left(k_{t+1} - s^E_t\right) - w_{t+1} l_{t+1} \tag{5.B.2}$$

This changes[59] optimal decisions of entrepreneurs:

$$\frac{\partial k_{t+1}}{\partial q_{t+1}} < 0, \frac{\partial l_{t+1}}{\partial q_{t+1}} < 0, \frac{\partial s^E_t}{\partial q_{t+1}} < 0 \tag{5.B.3}$$

which means that changing q from $q = 1$ to $q^* < 1$ leads *ceteris paribus* to an increase in capital demand, labor demand and savings of entrepreneurs. Along with that, as

[58] This can be considered as an expectation of technological breakthrough, and the suggested expected production technology is a variation of AK-production function. I introduce $A = \frac{1}{q}$ and leave shock parameter q below unit to make the results tractable and comparable with those in the text of the chapter.

[59] Overestimatioin of expected profit could also appear in a way

$$E^e_{t+1} = \frac{1}{q_{t+1}} \left[f\left(k_{t+1}, l_{t+1}\right) - \left(1 + r^C_{t+1}\right)\left(k_{t+1} - s^E_t\right) - w_{t+1} l_{t+1}\right]$$

In this case decisions of entrepreneurs with respect to capital and labour demand stay unchanged, and only the savings decision is influenced: increase in expected profit requires from entrepreneurs to increase their savings, which would lead to a downward shift of the CM-line and consequent decrease in both equilibrium initerest rate and equilibrium wage rate immediately before the deficits appear at the banks.

the new period starts and the actual production stays at the level $f(k_{t+1}, l_{t+1})$, entrepreneurs repay first to workers $e_{t+1} = \min(w_{t+1}l_{t+1}, f(k_{t+1}, l_{t+1}))$. The possibility of the default changes now the priority of payments, so that out of the amount of $f(k_{t+1}, l_{t+1}) - e_{t+1}$, first are paid entrepreneurs in amount of planned consumption (if achievable) $\widehat{E}_{t+1} = \min\left(f(k_{t+1}, l_{t+1}) - e_{t+1}, E^e_{t+1}\right)$, where $E^e_{t+1} = \frac{1}{q_{t+1}} f(k_{t+1}, l_{t+1}) - \left(1 + r^C_{t+1}\right)\left(k_{t+1} - s^E_t\right) - w_{t+1}l_{t+1}$ and the rest is obtained by the banks (creditors) as debt repayment $b_{t+1} = f(k_{t+1}, l_{t+1}) - e_{t+1} - \widehat{E}_{t+1}$. Assuming this shock influencing only banks, i.e. $w_{t+1}l_{t+1} < f(k_{t+1}, l_{t+1})$ and $f(k_{t+1}, l_{t+1}) - w_{t+1}l_{t+1} < E^e_{t+1}$, one obtains $e_{t+1} = w_{t+1}l_{t+1}$, $\widehat{E}_{t+1} = E^e_{t+1}$ and $b_{t+1} = \left(1 + r^C_{t+1}\right)\left(k_{t+1} - s^E_t\right) - \left(\frac{1}{q} - 1\right) f(k_{t+1}, l_{t+1})$, which is equivalent to **(??)** and leads to deficits in banking sector.

This case differs from the one in text of chapter in that the interest rate and the wage start to change one period *before* the deficits appear in banking sector. Further development is still driven by the dynamics of deficits. As the shock is still exogenous, and the driving force is concentrated in banks' deficits, which dynamics is not influenced by the nature of shock, I have transferred the impact of shock directly to deficits in the text of chapter in order to simplify the exposition.

Appendix 5.C

Proofs

Proposition **??** is proved in the text of the chapter.

Proof of Proposition **??**

Proof.

The credit market equilibrium condition and the definition of deficits in the map for deficits in (**??**) for period t imply

$$d_{t+1} = (1 + r_{t+1})d_t \tag{5.C.1}$$

where $r_{t+1} = r^D_{t+1} = r^C_{t+1}$. In a stationary steady state, $d_{t+1} = d_t = d$. Therefore, condition (**??**) turns into

$$d = (1 + r_{t+1})d$$

Under a positive interest rate, the latter is true if and only if

$$d = 0$$

The first part of the statement is hence proved. The second part follows from Proposition 4.5.

Additionally, one can consider a modified map $\Phi_0(w_t) \equiv \Phi(w_t, 0)$:

$$\Phi_0(w_t) : \begin{cases} (1-\eta)l_{t+1} = 1 \\ (1-\eta)\left(k_{t+1} - s^E_t\right) = \eta s^W_t \end{cases} \tag{5.C.2}$$

with the rest defined as in (**??**). To prove the existence of the stationary it suffices to prove the existence of a solution to

$$w_{t+1} = \Phi_0(w_t) = w_t$$

Substituting w_{t+1} instead of w_t into the labor demand, credit demand and savings functions in (**??**) reduces the problem to the case of market equilibrium. The slope of LM-line stays unchanged, since depends only on w_{t+1}, and the slope of LM-line is always flatter than that of the LM-line (see Lemma 4.2 in Appendix 4.A to Chapter 4), therefore the general equilibrium exists for any value of w_t, and in particular for some value $\overline{w}$, for which the condition $\Phi_0(\overline{w}) = \overline{w}$ is met. By construction, this steady state does not depend on initial conditions.

■

Chapter 6
Handling a Financial Crisis: Russian Default in 1998 and International Comparison

This chapter discusses a possible application of the model developed in the previous two chapters to the Russian Default in 1998. The chapter begins with a presentation of some stylized facts about the Russian economy on the eve of the crisis. At the same time, these facts are compared with the assumptions made in the theoretical model. Further sections describe the policy measures, which have been implemented by the Russian government and compare them with those theoretically studied. Finally, some international evidence on the applicability of the model is provided.

6.1 The Crisis and the Model

The Russian Default in 1998 had three main effects. Firstly, foreign debts were frozen, which was a signal for international investors to leave Russian financial markets; this resulted in a sharp decrease in prices at the stock and other financial markets. Secondly, the default on domestic bonds created huge losses for the major players in Russian state obligations (GKO) market; these were primarily banks which in turn defaulted on deposits. Thirdly, general panic led to a sharp devaluation of ruble, consumer prices skyrocketed, and the real wage fell upto four times. The attempts of the government authorities to control the situation (by fixing the exchange rate and threatening with "inspections and penalties" those firms who would raise prices) did not help, and the recovery lasted several years.

In this dissertation, I have compared the allocational efficiency of two contrasting financial systems: a market-based and a bank-based one. The analysis in Chapter 5 was particularly devoted to the study of the differences which may arise in the macroeconomic development of the market economy and the intermediated one after a macroeconomic shock. This sheds some light on the question, whether a financial system might be structured in a way to lower the financial crisis burden borne by the population, and which government interventions might be needed to reduce the negative consequences of the crisis. The OLG-setting used in Chapters 3 - 5 may be applied to the study of short periods, under the assumption that the long-lived agents are rather myopic, and make decisions in each period only for the next period of their lives instead of maximizing life-time utility over [infinite] number of periods. This seems to be valid in case of unawareness of the agents with respect to the long-run future and impossibility to predict more than for one period, which is mostly the case in a crisis situation. This may be supported by the observation that the duration of long-term loans in Russia in the 1990s did not exceed 3 years (and in the worst cases even a 6-month loan was considered to be a long-term one, whereas short-term loans were granted for less than one month). With regard to the term structure of deposits with Russian banks, Entov (2001) notes:

> *"The increase of uncertainty during the transition period and the outburst of inflation in the first half of the 90's were reflected in the term structure of bank liabilities: the share of long-term liabilities tended to be extremely small. It is enough to say that by the beginning of 1998, the share of households' demand deposits and that of time deposits up to three months together in Sberbank [the state controlled largest bank in Russia that time - D.V.] and other commercial banks was no less than two-thirds of all deposits and about 80-90% of the rest was represented by the liabilities up to one year" (p. 63)*

The main feature of the model is an unpredictable shock, which influences the asset-side of the banks' balance-sheet, or directly the earnings of the population in the case of a market-dominated system. As in the case of the Russian default, this shock deteriorates balance-sheets and leads to a decrease in the real wages of population. As a regulation measure I assume state guarantees on deposits, which prevent bank runs, and consider under this assumption two additional interventions: a liquidity injection to let banking system stay solvent, and a deposit rate ceiling, which creates a positive interest rate margin to recover the capital of banks. Under these circumstances, the bank-based system may recover after the shock and distribute the burden of the shock over several periods, whereas the market-based system leads to a huge burden borne by people in one period and does not provide intertemporal risk-smoothing. Still, to provide the banking system with a capacity of an intertemporal shock smoothing, proper regulatory interventions are needed. I will address this issue as well.

In this chapter, I neither focus on the detailed description of the Russian Crisis of 1998 nor on the precise data analysis. The purpose of this Chapter is rather to illustrate some conclusions of the model developed in Chapters 4 and 5 using the example of the Russian Crisis and to provide some international comparison. A detailed chronology of the Crisis is given in Appendix **??**. See also Robinson (2003) for a more detailed account of the circumstances of the August 1998 crisis and the striking lack of a coherent policy response during the remaining months of that year.

Firstly, I describe the Russian economy before the crisis, in order to reveal the applicability of the theoretical model. The years 1998 and 1999 present the situation before and immediately after the financial crisis of August 1998, and the years up to 2003 allow an insight into direction in which the Russian financial system developed after the crisis. Secondly, I draw some conclusions upon possible scenarios of macroeconomic development after the default in August 1998. Thirdly, I present some international comparison to support the conclusions of the model in the contexts different from the Russian default of 1998.

6.2 Stylized Facts about Russian Economy in 1998-1999

As Table **??** shows, the market for corporate bonds in 1998 and 1999 was strictly dominated by the market for credits from banking system to enterprises and by the market for state short-term obligations. Two main features are revealed with these figures: (1) the share of market-based finance is very small in financing the private sector, which is mostly financed through the banking system, and (2) market for state bonds is much more developed in comparison to the market for corporate bonds, although the former is not the primary source of finance for the government, which also relies on the banking system including monetary au-

	Corporate bonds	Bank credits to enter-preises	State bonds	Credits from monetary authorities to RF Government	Bank credits to government bodies
1998	20,7	300,2	387,1	483,5	263,7
1999	28,6	445,2	266,9	496,2	445,3
2000	38,9	763,3	184,2	264,2	532,7
2001	67,2	1191,5	160,1	193,2	588,7
2002	108,9	1612,7	217	193,7	696
2003	157,6	2299,9	314,6	31,7	742,8

Table 6.1. Financial sources in Russia. Source: BEA (2004)

thorities. These two features are mostly associated with the absence of credit histories of the enterprises, which is quite common for transitory countries.

The year 1999 demonstrates the shrinking of the market for government bonds ("State bonds" in Table **??**), which are mostly replaced by the indirect finance through banking system and monetary authorities. This immediate reaction of the markets to the default of August 1998 develops further and leads in 2003 to diminishing of the market finance for the government and almost disappearing credits to the RF Government from monetary authorities, with banking finance keeping leading role as the financial source both for the government and for the enterprises.

This is the **first stylized fact**, which has relevance to the model: *enterprises are financed primarily by banks*; the role of financial markets for private securities is negligible, and hence Russian economy can be viewed as bank-dominated.

Considering banking sector in 1998, one can reveal the **second stylized fact** about Russian financial system (Figure **??**): *banks obtain funds primarily through deposits*; second and third important sources are the shareholders capital and the funds of foreign investors, neither of which exceeds 50% of the amount of deposits collected. All other sources of funds are relatively small. In the model, it is assumed that deposits constitute the only source of funds for banks.

The role of the foreign debt may be twofold. On the one hand, as Entov (2001) points out, in the period 1996-1998, foreign debt was less expensive than Russian domestic debt. One might expect that the existence of a cheap source of funds would contribute to the creation of the interest rate margin, which plays a crucial role in the recovery of the banking system

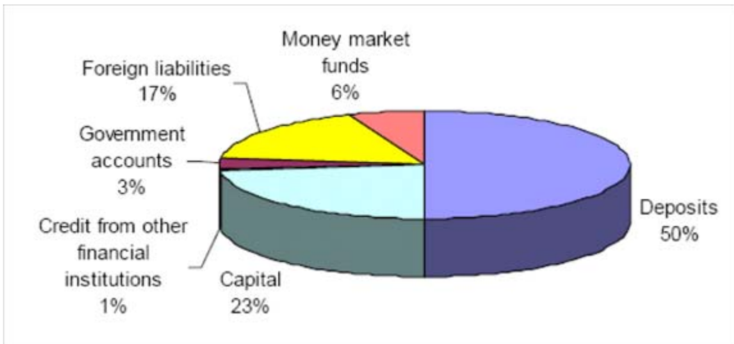

Figure 6.1. Financial Sources of Russian Banks in June 1998. *Source*: CBRF (1999)

after a shock in the model. On the other hand, the foreign liabilities of the banks were mostly in the form of short-term debts, which might contribute to the shrinking of funds available to banks immediately after the shock.

The **third stylized fact** about Russian financial system on the eve of financial crisis: *banks' securities portfolio is not diversified* and mostly concentrated in state bonds: more than 84% of banks' portfolios consisted of state bonds two months before the crisis. (Figure **??**). Entov (2001) notes that even in 1997 about 55-60% of the state bonds outstanding were concentrated in the Central Bank of the Russian Federation, the Sberbank, and the Vneshtorgbank (the Bank for Foreign Trade, another state-controlled bank in Russia), with other banks actively involved in the speculative trade with the state bonds in the secondary markets.

I did not introduce government securities as an investment opportunity for banks in the model. Instead, I have considered production sector, assuming no diversification. Nevertheless, the payment shock considered in the model has the same influence on banks' balance sheets as the default of Russian Government in August 1998, which led to a sharp reduction of the book value of the assets side, and hence to the shortage of funds available for deposit repayments. The increase of the rate of return on the state bonds (which reached the annual rate of 150% in May 1998) triggered a significant increase of the deposit rates, and after the Default banks were unable to meet their obligations in full. In terms of the model, banks experience deficits, which are the driving force of the crisis in Chapter 5.

And finally, the **fourth stylized fact** about Russian financial system: *deposits with the*

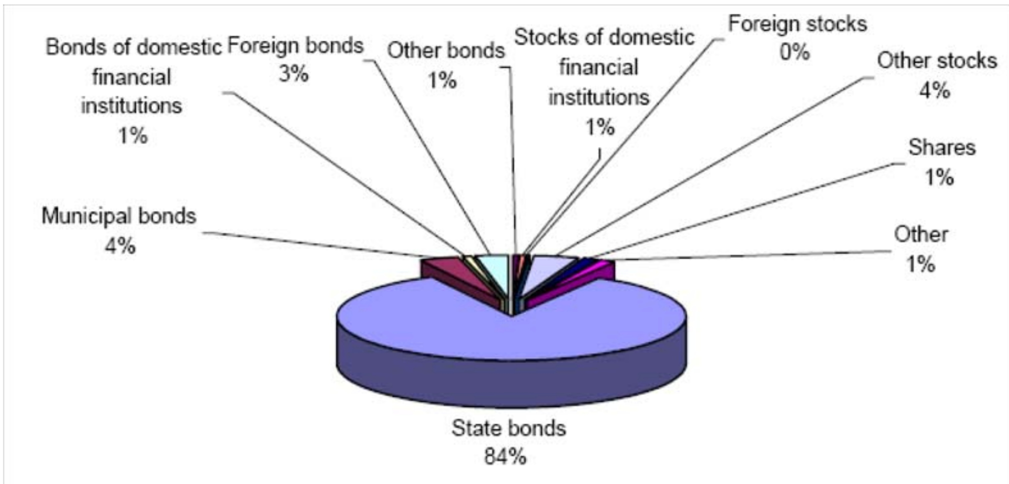

Figure 6.2. Securities portfolios of Russian banks in June 1998. *Source*: CBRF (1999)

banking system dominate among the forms of savings of the population. The structure of savings is presented in Figure **??**. Three main components of the savings of population can be seen: (1) domestic (ruble) cash, (2) deposits with the banking system (which include ruble deposits with Sberbank, ruble deposits with other banks, and deposits in foreign currency, "Forex deposits" in Figure **??**), and (3) foreign cash as the principal available substitute to deposits. The share of securities is relatively small. Total deposits with the banking system approaches 42%, which is twice as much as the cash money holdings by the population.

In the model, it is assumed that there is the only form of savings available to the population, namely deposits with banks. One can see that there is a large share of foreign cash used by the Russian population as a cushion against inflation: the share of foreign cash (mostly US dollars) was about 29% in 1998. Surprisingly, in contrast to banks, which did not hedge against possible devaluation of the ruble, the population as a whole did. This partially protected people from a significant decrease in consumption in the aftermath of the Default.

Finally, it should be stressed, there was no deposit insurance in Russia. Below one can see that this provoked a large-scaled banking panic immediately after the Default.

6.3 Evolution of Russian Crisis After the Default

The model predicts four possible scenarios for a bank-dominated economy: (1) the de-

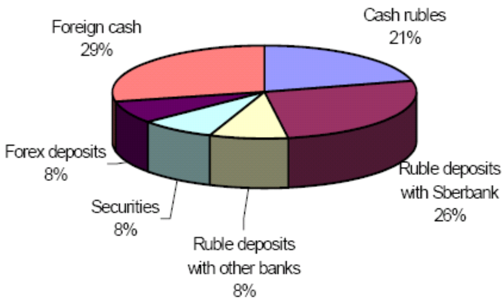

Figure 6.3. Structure of Savings in Russian Federation in 1998. Source: BEA (1999)

terioration of the economic situation and the collapse of the banking system if there is no regulatory intervention after the shock; (2) delay of the real effect of the payments shock if repeated unrestricted liquidity injections are implemented by the regulator; (3) relatively quick recovery of the economy, leaving the burden of the payments shock on depositors, who are underpaid on their deposits, if short-term restricted liquidity injections are used; and (4) longer lasting recovery, which smoothens the negative consequences of the payments shock over several periods, if a regulatory measure is chosen which allows banks to exploit positive profit margin (e.g. deposit interest rate ceiling considered in Chapter 5). The intervention of the Central Bank of Russian Federation (CBRF) immediately after the crisis in August 1998, was the following (see Thießen, 2000):

(1) CBRF allowed banks to draw on their reserve requirements to make payments;
(2) CBRF supported off-sets of liabilities between the banks;
(3) CBRF provided "stabilization credits" to problem banks;
(4) CBRF guaranteed deposits in the state owned Sberbank and stimulated the transfer of deposits from other banking institutions to the Sberbank.

6.3.1 Capital Deterioration, Liquidity Injections and Slow Recovery

In total, the Central Bank increased its lending to commercial banks in the 10 months after June 1998 almost six times in real terms, with an initial increase in the lending in August 1998, followed by a decrease in the lending until November 1998, as shown in the Figure **??**. Starting November 1998, banks could obtain more and more funds from the CBRF. These

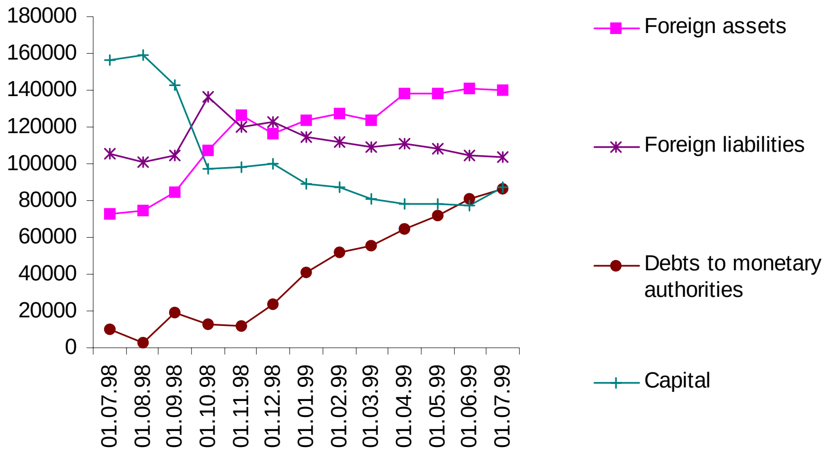

Figure 6.4. Evolution of the capital, foreign assets and foreign liabilities of the banks, and the role of the liquidity assistance in Russia in 1998-1999 (in real terms, the CPI is taken 100% as for 01.07.98). *Source*: CBRF (1999), own calculations.

measures correspond in large to liquidity injections studied in Chapter 5. As the model predicts, liquidity injections alone cannot provide for the recovery of the banking system, especially if the access to the "stabilization credits" is unrestricted. Figure **??** shows that the banking capital deteriorated sharply in August and September 1998, and despite large scale liquidity injections afterwards, a further decline in the capital of banks could not be avoided.

The first reason for that was the forbearance policy chosen by the CBRF: only in the middle of 1999, about 10 months after the crisis, the authorities suggested a strategy to "restructure" banks[60]. The second reason was the inability of banking system to create a profit margin, which would allow to cover the lack of capital (which is presented in the model in Chapter 5 as deficits).

In Figure **??**, it can be seen, that the amount of real credits granted by banks in total to the enterprises and the RF Government experienced reduction immediately after the crisis together with the amount of deposits and banking capital, and stabilized in about three months after the default. Although the figure demonstrates slightly positive trend in the amount of funds accumulated by banks through deposits and money market instruments starting the beginning of the 1999, the trend of the capital stays negative until mid-1999 (compare with

60 Restructuring is a mixed form of an insolvency resolution, which includes bridge bank, acquisition and partial liquidation together with possible debt renegotiations.

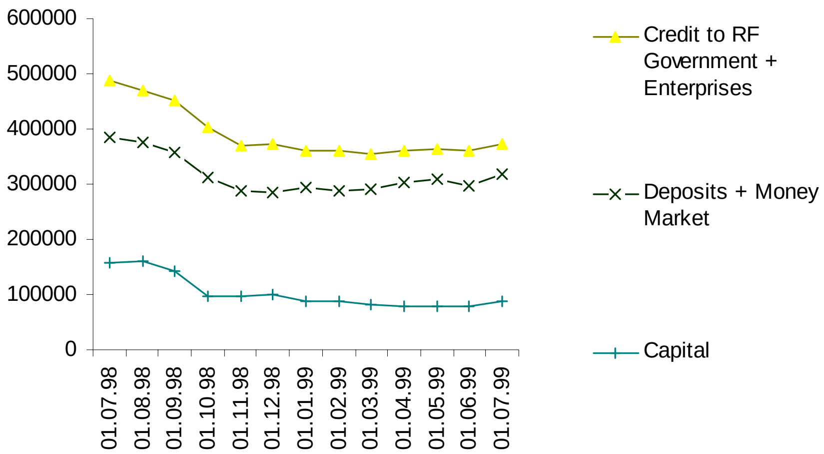

Figure 6.5. The evolution of banking capital, credit and deposit portfolios in Russia in 1998-1999 (in real terms, the CPI is taken 100% as for 01.07.98). *Source*: CBRF (1999), own calculations.

Figure **??**).

Figure **??** represents the simplified balance sheet of the banks, as assumed in the model, except that one has now to take into account the existence of the banking capital (which in the model was assumed to be zero). It is easy to see that the banking capital deteriorates with the time. Figure **??** provides a more detailed picture: the decrease in the capital and the decrease in the foreign debts of banks are overcompensated by the loans from the monetary authorities. However, this did not lead to a recovery of credits granted by the banks in the domestic market, but leads to a significant increase in foreign assets.

In the model, it was assumed that the capital of banks is zero, and the only deterioration of the balance sheets was possible through deficits in the banking system. Instead of deficits in the model, one has to expect decrease in capital in the aftermath of the crisis. Actual reduction in banking capital in Russia in 1998-1999 may be seen in Figure **??**. The same figure demonstrates that the liquidity assistance from the central bank was not prompt, and Russian banks in the beginning covered the lack of capital through borrowing from abroad. As the CBRF intervened with liquidity injections, this assistance did not help anymore to improve the capitalization of banks, but rather replaced foreign credits. In the absence of any deposit insurance scheme (both explicit or implicit), the delay with liquidity assistance

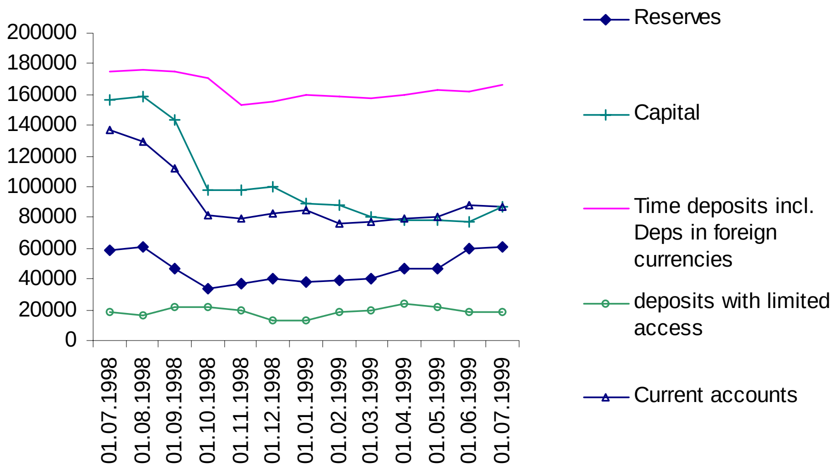

Figure 6.6. The evolution of banking capital, deposits and reserves in Russia in 1998-1999 (in real terms, the CPI is taken 100% as for 01.07.98). *Source*: CBRF (1999), own calculations.

was extremely harmful for the banking sector and led to a banking panic.

Although the availability of funds from the CBRF allowed banks to improve their reserves starting 1999, as shown in Figure **??**, banking reserves suffered a lot from the banking panic immediately after the Default. The banks even imposed limitations on payoffs on demand deposits. The decline in the amount of demand deposits ("Current Accounts" in Figure **??**) is stronger than the decline in reserves, since much of the demand deposits were transferred into time deposits or were "frozen", so that the access to them was limited (deposits with limited access in the figure). Usually, the illiquidity resolution chosen by the banks included the following: (1) a delay in payoffs is introduced for a week or longer; (2) a limited amount[61] of money from the current account is paid off; (3) the rest is transferred to the time deposit. A scheme supported by the RF Government included transfer of deposits to the state controlled Sberbank, which, in turn, also introduced limited access to the deposits.

[61] Sometimes depositors were requested to provide an evidence that they urgently need cash, otherwise they were refused in their access to accounts. A usual type of such evidence could be a "spravka" (letter of confirmation) from a hospital or a funeral agency, with an indicatioin that an urgent medical treatment, surgery or even death of an imaginated relative induced unexpected "costs", which had to be paid immediately.

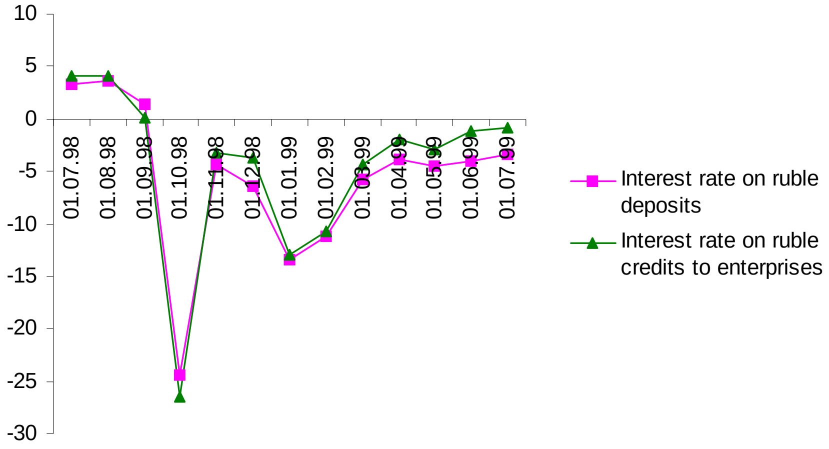

Figure 6.7. The evolution of real monthly interest rates in 1998-1999. *Source*: CBRF (1999), own calculations.

6.3.2 Interest Rate Margin

Somewhat surprising is the evolution of real interest rates, which is presented in Figure **??**. As expected from the model, the absence of regulatory interventions, which could create positive profit margin for banks, results in almost equality of interest rates, and only starting mid-1999 did the interest rate gap begin to increase (Fig. **??**). However, both interest rates fall, although the model would predict them to rise (if there is a shortage of funds in the market) or to stay stable (if there are continuous liquidity injections from the side of the Regulator, which was the case).

A possible explanation for this fact is the scarcity of credits granted by banks, and the credit rationing, not considered in the model. Under these conditions banks may leave nominal credit rate almost unchanged, and hence the reduction in real rate is caused by the increase in inflation rates. Indeed, if the scope of banking lies mostly in the speculative trade with securities and in investment abroad, the credit rate set by the banks does not play any important role, since the banks opt to ration credit rather than to seek for qualitatively better domestic credit opportunities.

On the other hand, the real interest rates are calculated on the basis of announced nominal rates and the actual rate of inflation instead of the expected rate of inflation. In case expecta-

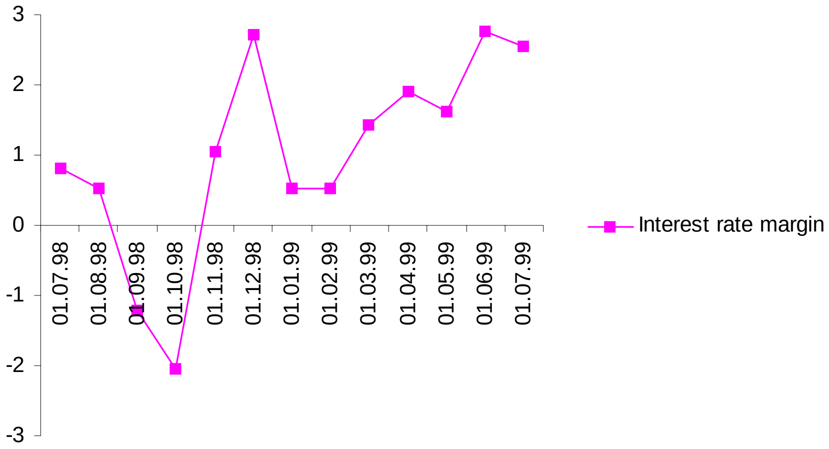

Figure 6.8. Interest rate margin as the difference between the credit rate and the deposit rate in Russia in 1998-1999. *Source*: CBRF (1999), own calculations.

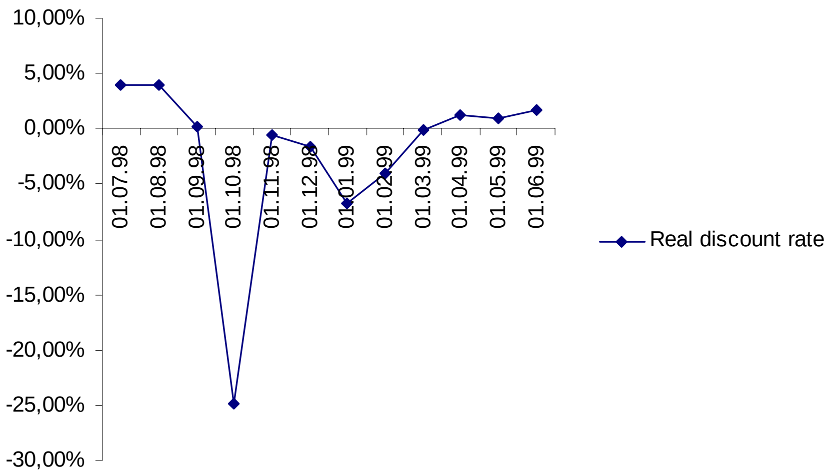

Figure 6.9. Real discount rate of the Central bank of the Russian Federation in 1998-1999 (monthly rate shown as the difference between the nominal monthly rate and the monthly rate of inflation, nominal annual rate fixed at 60%). *Source*: CBRF (1999), own calculations.

tions are not rational, they usually underestimate future inflation in the times of accelerating inflation. As a result, calculated real rates may move opposite to a theoretically predicted direction.

Finally, the nominal discount rate of the central bank was fixed at the annualized level of 60% from 24.07.98 till 09.06.99 (Table 2.2 in CBRF, 1999). Given the inflation dynamics, it resulted in a sharp fall of the real discount rate (Fig. **??**), which caused other real interest rates to fall as well.

6.3.3 Wealth Effects of the Crisis

According to the Bureau of Economic Analysis (BEA, 1999), the real income of the population decreased in the aftermath of the crisis by about 20%. At the beginning of the current chapter, I have indicated the figure of up to four-times wealth decrease. Montes and Popov (1999) witness that within a few days after August 17, 1998, the Russian ruble, which had been relatively stable during the preceding three years, lost more than 60 percent of its value vis-à-vis the dollar; prices increased by 50 percent within just two months of the crisis, as compared to less than 1 percent monthly inflation before the crisis; and real output fell by about 6 percent in 1998 after registering a small increase (for the first time since 1989) of 0.6 percent in 1997. This drastic difference in evidence has several explanations.

First, it is the difference between the short-term and the long-term effects. The Default was announced on Monday, the 17th of August, 1998. Immediately after this US dollar exchange rate skyrocketed from about 6 rubles per dollar to above 20 rubles per dollar, and the Central Bank denounced the results of trade in the currency exchange. The official exchange rate was fixed during several days. The market exchange rate could not be determined, since the trade at the currency exchange was interrupted by the CBRF each time the dollar exchange rate exceeded 20 rubles point. The goods prices grew moderately, since most shops closed instead of revising the prices, which were often linked to the exchange rate. One may call this period moderately inflationary in absence of the devaluation.

The following week started with the attempts of the Government to prevent the inflation. The tax police announced it would inspect all vendors who increased the prices. Formally, one could not penalize for an increase in prices, but under no legislative determinism any

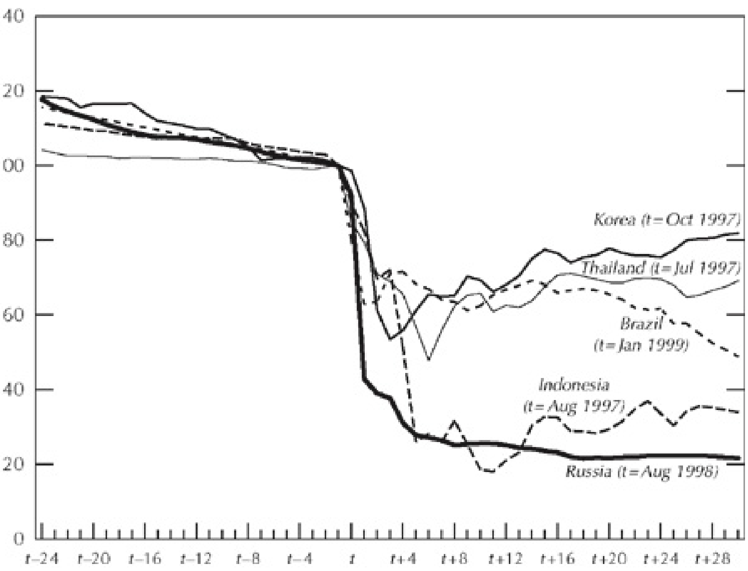

Figure 6.10. Nominal exchange rates in selected crisis countries (US dollar per unit of local currency, t is the crisis start, one period corresponds to one month, index 100% as of $t-1$). *Reprinted from*: Owen and Robinson (2003)

inspection could be dangerous for firms, so that the threat from the tax police was effective. The prices stood frozen for about a week, though the exchange rate changed. This was a week of a paradoxical devaluation in absence of inflation.

As a result, the almost 4% average increase in prices in August 1999 was achieved only in the last 5 days of the month. September inflation approached 50% (monthly rate). The estimation of 60% devaluation of the ruble by Montes and Popov (1999) above stems from the change of the exchange rate in dollars per ruble, which roughly corresponds to a 2,5-times increase in the rubles-per-dollar official rate.[62] Owen and Robinson note that "the Russian crisis resulted in a relatively steep nominal-exchange-rate adjustment and a much higher spike in inflation than in most of the other countries that experienced financial crises over the past decade." For a comparison, see Figure **??**.

The above discussion demonstrates the difference between the shock impact and the subsequent events, as stressed in Chapter 5. Statistical averaging over several months smoothens

[62] This rate underestimates the actual street rate. Street exchange rather resembled a "black market" with no dollars available for sale at the regulated rate (the CBRF imposed an upper bound of 15% for the bid-ask spread).

the impact of the shock and does not reveal the detailed picture.

Secondly, the burden of the crisis was significantly smoothened by the fact, that there was an alternative storage technology available to depositors, namely US dollars, which are widely used in Russia in cash as a means of saving. This is a crucial difference between the model and the situation in Russia before and after the Default of 1998. As noted above, the population hedged against possible devaluation and diversified savings. This explains, why the estimates of the welfare change after the Default may differ. BEA (1999) estimates primarily consumer expenditures, which did not fall that significantly as the ruble income in the immediate aftermath of the shock.

Finally, there was a different impact across the population. Gerry and Li (2002) find, for example, that population in urban areas was more vulnerable to the shock in terms of their welfare reduction than the country side population, which could exploit home production to protect themselves against the shock. Furthermore, the authors discover the existence of an informal safety net, within which help from relatives acted to decrease vulnerability. Finally, Gerry and Li (2002) also distinguish between the shock impact (short-term effect) and the shock aftermath (long-term effect) and show that in the long run, the better educated people from urban areas suffered least from the Default. This heterogeneity of population may contribute to the differences in judgments about the welfare effect of the crisis.

In general, no intervention from the Government protected the population from welfare losses. In terms of the model, the generation of depositors of the shock period suffered more than the future generations. In this sense, the Russian banking system could not provide better shock smoothing than a market-based system would. At the same time, it could not provide facilities for a quick recovery, which the model in Chapters 4-5 shows be the advantage of the market-based system. Liquidity injections from the Central Bank, and the forbearance with regard to insolvency resolutions together with the absence of a deposit insurance system, contributed to the duration of the crisis.

6.3.4 Policy Implications

Comparing the results of the model with the empirical data on the financial crisis in Russia in 1998, the following policy implications may be drawn:

(1) Existence of developed financial markets and market-based financial system in a country would accelerate the recovery after a sharp macroeconomic shock (in the model it is the payment shock). However, from the institutional perspective establishing a market-oriented financial system is a more difficult task, especially in emerging and developing economies. A banking system is easier to establish, but needs proper regulation and intervention mechanisms in case of crisis to avoid a collapse. With a market-based financial system, the burden of the crisis is borne by the population immediately after the macroeconomic shock, and other (perhaps fiscal) means may be needed in order to smoothen this burden.

(2) A banking system allows for a postponing and a smoothening of the negative effects of a crisis. Postponing can be achieved through liquidity injections, and smoothening through regulatory intervention leading to positive profit margin. In the first case the burden of the crisis can be shared by depositors and the Regulator, and in the second case it is shared between several generations of population.

(3) Additional storage technology (like foreign currency used by the Russian population against inflation and banking risk) provides a cushion against negative effects of the crisis for the population.

6.4 International Comparison

The Russian Crisis of 1998 is just one example of the large number of financial crises which the world faced in 1980s and 1990s. I briefly reviewed the empirical literature on crises in Chapter 1. In the first part of the current chapter, I discussed the way Russian Government attempted to control the crisis of 1998 (which was triggered by the default of the RF Government), and in how far the model of Chapters 4 and 5 helps in understanding this way. Below, I extend the discussion of the handling of financial crises with some examples, which do not attempt to be exhaustive, but rather are designed to illustrate the applicability of the model.

6.4.1 Japanese Crisis

One might attribute the beginning of the Japanese banking crises to the fall in real estate prices and the slowing of the macroeconomy in the early 1990s. After that, the banking sector became very weak and many banks were undercapitalized. Although the system of deposit insurance had existed in Japan since 1971, the Deposit Insurance Corporation of Japan extended in 1996 its guarantees to all bank deposits without any upper limit.[63] In addition to such explicit guarantees on deposits, the Banking Bureau of the Ministry of Finance followed the policy of supervisory forbearance, which allowed banks with non-performing loans to operate further. Kocherlakota and Shim (2005) note that Japanese banking regulators have been often criticized for both blanket guarantees on deposits and the extreme aversion to the liquidation of problem banks.

Dekle and Kletzer (2003) suggest an endogenous growth model to study the Japanese banking crisis and the role of deposit guarantees and forbearance in the crisis development. They argue that the Japanese financial system is in large bank-dominated. This makes my model from Chapters 4-5 also applicable to the Japanese case. Dekle and Kletzer (2003) refer to the dating of the onset of the banking crisis in Japan as "tricky". They note that on the one hand, it may be the beginning of the 1990s, with the Japanese Ministry of Finance admitting the presence of rising bad loans in 1992, and on the other hand, it may be the East Asian Financial crisis of 1997-1998, with a remark that the "remain agnostic with the dating of the onset of the banking crisis". In my model, the dating of the crisis should be attributed to the beginning of the period, when the first non-performing loans appear, and the banks experience deficits, hence the relevant period starts in the beginning of the 1990s.

My model predicts the decline in production and consumption in the aftermath of the crisis, and the accumulation of the banks deficits if the regulator does not intervene properly. The Japanese economy experienced declines in the growth rates of consumption and production starting 1990s. In contrast to Dekle and Kletzer (2003), my model does not predict a decline in investment *before* the crisis (which Dekle and Kletzer characterize as the anticipation of the crisis), but rather exactly after the crisis. Dekle and Kletzer witness that investment growth rates fell in Japan only in the aftermath of the crisis, not before it. It

63 Before 1996 only deposits up to 10 mln yen per person per bank had been guaranteed.

should, however, be noted that my model in Chapters 4-5 is formulated in real terms, not in terms of growth rates. Since in my model the steady state growth rate is zero, a decline in it can only mean a decline in the variable, this explains the difference between my results and the data on Japanese banking crisis. An extension of the model to account for positive steady state growth rates may be a direction for the future work.

Gersbach and Wenzelburger (2002a[64]) note "some countries responded to banking crises and associated economic downturns by lowering short-term interest rates", as advocated by the theory. The Bank of Japan lowered the interest rates quite drastically, and they reached virtually zero in February 1999. Remember, in case of Russia, the dynamics of interest rates also contradicted to the one predicted in the model in Chapter 5. The decrease in interest rates was due to the discount rate policy of the regulator. In my model, I argue that a decrease in interest rates may have an anti-crisis effect, if it is asymmetrical in the credit and the deposit market, which neither was the case in Japan, nor was it the case in Russia. The Japanese paradox (long-lasting crisis with no collapse and no recovery) may be attributed to the extraordinary constellation of interest rates, which approached zero. Under these circumstances, my model predicts no accumulation of deficits and the collapse may be postponed virtually infinitely long.

Finally, Kocherlakota and Shim (2005) argue that both insurance of deposits and forbearance by Japanese bank regulators may have been ex-ante optimal in presence of the shocks on the collateral value. The intuition behind it is that an ex-ante decision depends on the nature of the shock and does not necessarily lead to an optimal choice in favor of the prompt liquidation, even if the prompt liquidation of an insolvent bank seems to be ex-ante optimal. In Chapter 3, I show that the [uncertain] forbearance makes banks internalizing the costs of failure, which has a positive effect in balance to possible negative effects of the deposit insurance, and hence forbearance may be ex-ante optimal. In Chapter 5, I consider forbearance combined with deposit insurance, and show that it may be ex-post optimal, if it is complemented with prompt interventions. In this case forbearance let the banking system to smoothen the negative effects of a crisis triggering shock over several periods, which may be socially optimal. It is important that the complementary interventions provide for a profit

64 Here I quote the revised version of 2005, entitled "Stability of Banking Systems, Interventions and the Macroeconomy".

margin of the banks, which may be used to cover the deficits.

6.4.2 Swedish Crisis

Englund (1999) summarizes the roots and consequences of the banking crisis in Sweden as follows:

> *"Newly deregulated credit markets after 1985 stimulated a competitive process between financial institutions where expansion was given priority. Combined with an expansive macro policy, this contributed to an asset price boom. The subsequent crisis resulted from a highly leveraged private sector being simultaneously hit by three major exogenous events: a shift in monetary policy with an increase in pre-tax interest rates, a tax reform that increased after tax interest rates, and the ERM[65] crisis. Combined with some overinvestment in commercial property, high real interest rates contributed to breaking the boom in real estate prices and triggering a downward price spiral resulting in bankruptcies and massive credit losses. The government rescued the banking system by issuing a general guarantee of bank obligations. The total direct cost to the taxpayer of the salvage has been estimated at around 2 per cent of GDP".*

Although the Swedish banking crisis also could be seen as a shock-triggered event[66], it differed a lot from the Russian and Japanese banking crises described above. The main difference is the massive government rescue operation in order to prevent the collapse of the Swedish financial system, in particular the payment system. At the early beginning of the Swedish banking crisis, the Bank Support Authority was established once the authorities made the decision to allow rescues of troubled banks. Viotti (2000) stresses three principal issues with regard to handling the banking crisis in Sweden: (1) a general government guarantee was issued for the repayment of all claims on the Swedish banking sector; (2) a rescue operation was set up in the form of a new government body created to support troubled banks; (3) the importance of managing the banking crisis as openly as possible was stressed.

Compared to the Japanese banking crisis, the Swedish one was relatively short: it started

[65] The ERM (Exchange Rate Mechanism) is a fixed exchange rate system, which together with the ECU (European Currency Unit) constituted the European Monetary System (EMS) in the 1980s-1990s.

[66] An overheated economy led to a speculative real estate price bubble that burst at the beginning of the 1990s due to a real interest rate shock. As a result, the banking system experience deficits, which corresponds in large to the definition of the payments shock in Chapter 5.

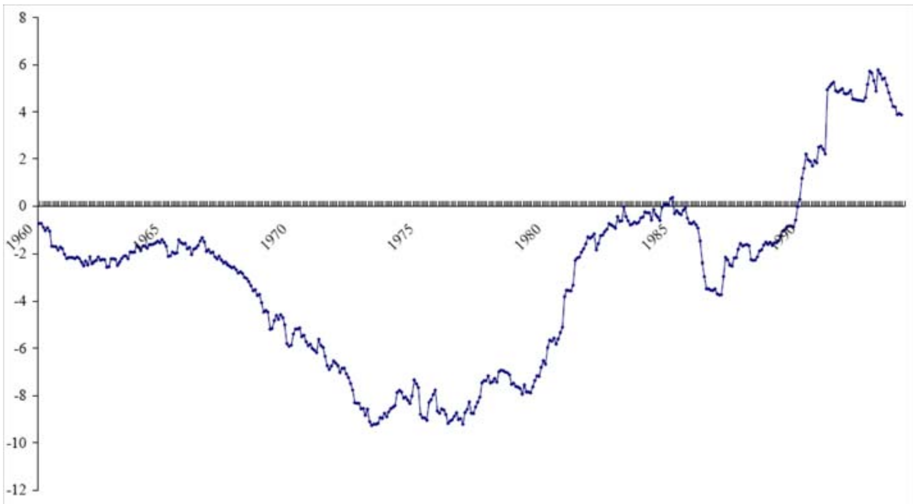

Figure 6.11. Ex-post 5-year after tax real interest rate in Sweden. *Reprinted from*: Englund (1999)

in 1991 and the acute phase of it might be considered to have been over by the autumn of 1993.[67] Compared to the Russian banking crisis, the Swedish one was much less harmful for the economy.

From the point of view of the model developed in Chapters 4-5, the prompt reaction of the Swedish banking authorities were liquidity injections. Corbett and Mitchell (2000) note that the procedure of such liquidity assistance was quite restrictive. The cost to the government of supporting the banks was to be kept as low as possible, which meant that banks requesting support would have to agree to a comprehensive review of their operations; any injections of government funds would be on as close to normal commercial terms as possible; and the government guarantee did not extend to the banks' shareholders.

As I noted in Chapter 5, the banking system may relatively quickly recover after the shock, if the banks internalize the costs of bailouts, and the liquidity assistance is restrictive. This is exactly the case of Sweden: the regulator was able to influence the decision-making by banks. In a way, it may be seen as a regulatory destruction of the competitive structure of the banking sector.

As my model predicts, the crisis led to a sharp increase in the real interest rates, which

67 Viotti (2000) writes: "Despite temporary rescue operations following acute problems at Nordbanken and Första Sparbanken in 1991, the crisis worsened in 1992 and engulfed the entire banking sector".

had been negative over three decades before the crisis (see Figure **??**). If the initial rise in the interest rates in 1990 may be attributed to the exogenous events, which have triggered the crisis, the subsequent rise in real interest rates in 1991-1992 and their high level until 1994-1995 should be attributed to the effects of the shock. Englund (1999) also reports on the increase in the interest rate margin in the banking sector during the crisis: "The margin between deposit and loan interest rates was down from 6.4 per cent in December 1992 to 4.4 per cent in December 1994... Subsequently, interest margins have come down further to little more than 3 per cent."

Russian banking regulators also chose liquidity assistance as the intervention to prevent the crisis, as did the Swedish authorities. However the access to the assistance was effectively unrestricted, and the regulators did not intervene in the decision-making of the banks. Together with the delay in the liquidity assistance, this contributed to the further deterioration of the balance sheets of banks in the aftermath of the Default. My model and the Swedish example show that if the regulator chooses liquidity assistance as a support measure during the crisis, it is important that a positive interest rate margin is created. As one could see above, the interest rate margin in Russia was negative immediately after the shock. On the contrary, Swedish banking system quickly achieved a positive interest rate margin of over 6%, which slowly decreased along with the recovery.

6.4.3 Other Examples

Banking sector problems became common in 1980s-1990s all over the world, and often they escalated to the crisis level. One of the first well documented crises of this era was the crisis of Savings and Loans Associations (S&L Crisis) in the USA at the beginning of 1980s. One of the principal interventions of the US Government to rescue the financial sector was the regulation of the competitive structure of the financial industry. The Glass-Steagall Act of the 1930s, which separated banking from stock markets, was abandoned to allow banks to enjoy higher rates of return in the stock market comparative to the credit market. This helped banks and S&L stay competitive against finance companies and mutual funds. My model is not directly applicable to the crises like the S&L one, since the principal triggering mechanism in my model is the shock, which induces deficits in the banking sector. In the case of the S&L Crisis, one has to consider the competition between the banking and the non-banking sector within the financial system, which is out of consideration in my model in Chapters 4-5. Nonetheless, with regard to insolvency resolutions, Chapters 2-3 suggest that the Prompt Corrective Action (PCA), which mostly means liquidation of insolvent institutions, may be not the best way to handle banking crises, since the expectations of it by banks may create inefficiency of the banking sector, especially if the competition within the banking sector is intense. Again, this result is less relevant for the American economy, which is in large market-based. This may explain the adherence of the American regulatory authorities to PCA-type interventions.

In many cases of systemic banking crises, however, policy-makers prefer to recapitalize insolvent banks. Even in the U.S., despite the official PCA-doctrine, insolvent banks are often allowed to continue operations and have access to the discount window. Corbett and Mitchell (2000) note: "it is a puzzling fact... that in many cases policy authorities make offer of bank rescue plans, yet banks are reluctant to accept these offers". The crises in Japan and Thailand (late 1990s) present some examples, in which banks were not enthusiastic about the recapitalization help from the government. At the same time, the above discussion of the Swedish crisis is a counterexample of a relatively quick recapitalization. The same concerns Norway and Korea. Corbett and Mitchell (2000) briefly discuss the similarities and differences in the recapitalization programs in Mexico, Thailand, Korea, Japan and Sweden, with some other examples like Hungary and Malaysia. McQuerry (1999) provides a discussion of the banking sector rescues in Mexico. Good references for the empirical analysis of financial and banking crises over the globe are Demirgüc and Kunt (1998 and 2000), Arteta and Eichengreen (2000) and Caprio and Klingebiel (1996).

Above, I have only presented the examples of Japan and Sweden, which differ in the forbearance policy and the usage of the liquidity assistance. Both countries may be described as bank-dominated and therefore present cases, to which my theoretical model could be applied. The case of Russia is rather a complicated mix of the two approaches (forbearance in absence of deposit insurance combined with liquidity assistance in absence of the regulation of the competitive structure). Since the objective of the current chapter was an illustration of the theoretical results, I do not expand into a discussion of the manifold of the crisis scenarios over the globe and over centuries, and limit myself with the three most characteristic cases.

6.5 Summary

The dynamic model from previous chapters incorporates both labor and capital markets and describes the role of financial intermediation in the evolution of the economy after a macroeconomic shock. As it follows from the analysis, deposit insurance itself can not prevent from a macroeconomic collapse, which corresponds to empirical findings of other authors[68]. This result is valid even if deposit insurance (bailout guarantees) cannot change risk incentives of the banks (since there is no possibility for shifts in investment decisions of the banks in our model). The model provides a tool for analysis of the regulatory interventions, and to study their efficiency in recovering the system after a shock.

A market-dominated system would provide quicker recovery after the shock, but would leave the burden of the crisis on one generation. Bank-dominated financial system can follow several different scenarios. Firstly, in absence of regulation, banking system can collapse, since covering deficits through newly accumulated deposits resemble a financial pyramid, and the indebtedness of the banking system grows from period to period. Secondly, liquidity injections from the regulator can postpone the collapse. Thirdly, a regulatory measure, which would create profit opportunities for banks (such as a deposit rate ceiling) gives rise for smooth recovery, during which the burden of the crisis is disseminated over several generations of the population.

In the case of Russian crisis in 1998, the Central Bank has chosen liquidity injections as a corrective action. Theoretically this can lead to a recovery or postpone the collapse, depending on the restrictions associated with the liquidity assistance. In practice, the injections retarded, which contributed to the deterioration of the situation. Fixed nominal discount rate acted as a kind of ceiling for both credit and deposit interest rates, and the banks had no possibility to exploit positive interest rate margin to cover the deficits. Both these actions could not contribute to any acceleration of the recovery. The fact that the crisis did not hit Russian economy even harder than it happened, is mainly due to the existence of alternative storage

68 For example, Demirgüc-Kunt and Detragiache (2000) question whether deposit insurance increases banking system stability; Barth, Caprio and Levine (2000) raise the same question with respect to regulation and ownership.

technologies, which were used by the population as a cushion against the crisis.

Japan provides an example of a long-lasting crisis due to the forbearance policy. The policy of low (almost zero) interest rates prevents the collapse, since banks can costlessly borrow from the future generations and shift the deficits from one period to another. The latest news with regard to some rising trend in inflation and interest rates may be a positive signal since if an interest rate margin occurs, banking system can recover and then accelerate the economic growth.

Sweden is an example of a very successful handling of the banking crisis at the beginning of the 1990s. Liquidity assistance to problem banks, combined with restrictions and regulatory influence on the decision-making by banks, created the conditions for a quick recovery. As predicted by the model, the crisis resulted in higher interest rates, but also in higher interest rate margin, which allowed banking sector to recover quickly.

Appendix 6.A

Chronology of the Russian Financial Crisis 1998

by Clifford Chance Moscow (see http://russianlaw.org/chron.htm)

23 March

Yeltsin fires Prime Minister Viktor Chernomyrdin and the entire Cabinet, saying reforms were not dynamic enough. He names virtually unknown Energy Minister Sergei Kiriyenko as acting prime minister. Markets already uneasy over turmoil in Asia and a slump in world oil prices are shocked, and many investors retreat to the sidelines amid the political uncertainty.

27 March

Yeltsin formally nominates Kiriyenko as premier, vowing to dissolve parliament if it fails to approve him, which it finally does one month later.

29 April

New Cabinet, packed with reformers, is announced. Markets mainly rise over this period, but major investors still sidelined.

12 May

Coal miners protest unpaid wages, blocking a major railway. Stocks tumble, due mainly to a law restricting foreign ownership of shares in electricity giant UES.

13 May

Russian markets fall further on news of Asian woes, amid violence in Indonesia and the poor state of Japan's economy.

26 May

Yeltsin signs austerity package to stabilize budget and cut spending. Russia suffers a blow as no one bids for a 75 percent stake in Rosneft, the last big oil company still in state hands. Finance minister announces spending cuts of $10 billion.

27 May

Central Bank triples key interest rate to 150 percent after GKO yields soar and shares tumble.

29 May

Influential Russian tycoons pledge to back Yeltsin. Yeltsin appoints Boris Fyodorov to head tax service.

4 June

Central Bank cuts key interest rate to 60 percent from 150 percent in a sign of growing confidence.

18 June

The International Monetary Fund delays an expected $670 million installment of its $9.2 billion loan to Russia, citing problems with implementing fiscal reforms.

19 June

Russia asks for additional $10 billion to $15 billion credit package from the IMF and other lenders.

23 June

Yeltsin and Kiriyenko present anti-crisis plan consisting mainly of tax laws. Yeltsin says the crisis has become "so acute that there are social and political dangers." He tells the Duma to waste no time in passing the laws, hinting at tough steps if it resists.

25 June

The IMF approves the release of the $670 million installment, but it fails to impress traders and shares fall again.

1 July

Siberian miners renew picketing of railways, demanding wage arrears and the resignation of Yeltsin and his government. Stocks tumble on overall uncertainty.

13 July

International lenders pledge $22.6 billion in extra credits spread over 1998 and 1999. Stocks briefly soar.

15 July

The State Duma fails to adopt most of government anti-crisis plan, approving measures that Kiriyenko says will provide only one-third of targeted revenues. He vows to compensate through government resolutions and presidential decrees, a legally questionable approach.

19 July

Yeltsin vetoes reduction in tax cuts and decrees a fourfold hike in land taxes after Duma rejects most of the revenue-raising elements in the anti-crisis package.

20 July

IMF approves its $11.2 billion share of the new international loans. First $4.8 billion made available.

29 July

Yeltsin cuts short his vacation and flies to Moscow citing "urgent business," prompting fears of a Cabinet reshuffle, although he replaces only Federal Security Service Chief.

4 August

Yeltsin resumes vacation in Valdai lake region.

6 August

World Bank approves $1.5 billion structural adjustment loan for Russia, including an immediate advance of $300 million.

10 August

Miners lift rail blockade after a temporary deal with the government. But stocks fall and GKO yields rise as investors take money out of Russian markets amid fears of devaluation and doubts over state finances.

12 August

Central bank says interbank market virtually paralyzed by liquidity problems and lack of confidence; imposes limits on purchases of foreign exchange by banks and says it will act to prevent crisis from spreading.

13 August

George Soros advises the Russian government to devalue rouble and introduce a currency board, pegging rouble to dollar or Euro. Central bank official says devaluation would not help solve crisis. Stocks plunge to lowest levels in more than two years and short-term GKO yields soar as banks dump paper for roubles. Central bank expands banks' access to overnight credits. Kiriyenko says there is no economic basis for the market decline and his government is in position to meet obligations.

14 August

Stocks rebound and debt market stabilizes. Yeltsin, on visit to Novgorod, rules out devaluation and backs Kiriyenko. He says he will not cut short his vacation and urges parliament to hold special meeting to consider government anti-crisis drafts. Russia's communist bloc backs Yeltsin's call for an extraordinary summer session of parliament, saying it should focus on the current crisis. Some major banks have trouble meeting payments to each other. Dollars become scarce on the street.

17 August

Statement of the Government and the Central Bank Government plans:

non-residents are not allowed to invest in short term (i.e. less than 1 year) rouble assets;

conversion of GKOs/OFZs into new governmental securities; and

90 day moratorium on certain hard currency transactions.

17 August

Decision of the Board of Directors of the Central Bank Imposes a 90 day moratorium on various hard currency transactions connected with the movement of capital.

17 August

Resolution of the Government No. 980 "On the Organization of Work for the Payment of Certain Types of State Securities" The Ministry of Finance is authorized to prepare draft legislation on the procedure for repayment of GKOs/OFZs maturing prior to 31 December 1998. GKOs/OFZs issued into circulation prior to 17 August 1998 to be repaid with new fixed-coupon federal loan bonds.

Kiriyenko insists the moves do not amount to a default on the debt or a devaluation of the rouble, but the exchange rate on the street collapses and Russians line up in a frantic search for dollars.

19 August

Central Bank telegram No. 177-T Generally restates the Decision of the Central Bank of 17 August 1998.

19 August

Central Bank Directive No. 320-U of 19 August 1998 "On currency operations of residents" Generally restates the Decision of the Central Bank of 17 August 1998 and provides that it is effective from the date of such Decision.

21 August

Statement of the Central Bank The Central Bank "intends" to provide state guarantees to private deposits in all Russian banks that have entered into an appropriate agreement with Sberbank.

21 August

Central Bank Directive No. 323-U The Central Bank limits the spread between the sale and purchase price of cash currency to 15 percent.

23 August

Presidential Decree No. 983 "On the Government of the Russian Federation" Kiriyenko's Government is dismissed and Chernomyrdin is named acting prime minister.

25 August

Presidential Decree No. 987 "On Performance of Duties by the Members of the Government of the Russian Federation" President instructs members of the Government (except Kiriyenko) to continue to serve until a new government is formed.

25 August

Presidential Decree No. 988 "On Certain Measures for Stabilizing the Financial System of the Russian Federation" The President instructs Chernomyrdin to prepare a procedure for redemption of GKOs/OFZs maturing prior to 31 December 1999.

25 August

Resolution of the Government No. 1007 "On Redemption of State Short-Term Zero-Coupon Bonds and Federal Loan Bonds with Fixed and Floating Coupon with Maturity up to 31 December 1999 and Issued into Circulation before 17 August 1998" Provides procedure for redemption of GKOs/OFZs issued prior to 17 August 1998 and maturing prior to 31 December 1999 and subsequent reinvestment of funds received upon redemption. Unlike Resolution of the Government No. 980 of 17 August 1998, the holders of GKOs/OFZs will be paid in roubles and not in "new securities".

26 August

Central Bank Directive No. 328-U of 26 August 1998 "On the introduction of temporary limitations on the execution by residents of operations connected with the movement of capital" A more extensive version of Central Bank Directive No. 320-U of 19 August 1998 providing that it is effective from 17 August 1998. It deals with closing loopholes in payments to non-residents under loans in excess of 180 days.

26 August

The Central Bank revokes the licence of Bank Imperial.

28 August

The Central Bank appoints a temporary administrator for SBS-AGRO Bank.

28 August

Central Bank Regulations No. 52-P "On the Procedure for the Issue of the Bonds of the Central Bank of the Russian Federation" and No. 53-P "On the Circulation of the Issues of Bonds of the Central Bank"

31 August

Chernomyrdin rejected by Duma as prime minister, 253 to 98.

31 August

Informational Notice from Central Bank and Ministry of Finance The Central Bank and the Ministry of Finance distributed an "Informational notice on the refinancing programme for state short-term zero-coupon bonds and federal loan bonds with fixed and floating coupons with maturity up to 31 December 1999 and issued into circulation prior to 17 August 1998" and a "Clarification on the Procedure for the Redemption of State Short-term Zero-coupon Bonds and Federal Loan Bonds with Fixed and Floating Coupon Yields with Maturity up to 31 December 1999 and Issued into Circulation Prior to 17 August 1998".

1 September

Central Bank Regulation No. 55-P of 1 September 1998 "On the Procedure for Effecting Payments in Foreign Currency under Export and Import Operations Performed by Residents of the Russian Federation" General rule: (i) for imports money should be paid only after goods have been delivered/services performed in Russia and (ii) in the case of exports, money should be paid before goods leave Russia.

1 September

Tokobank license revoked by Central Bank. The Central Bank discloses details of its plan to provide state guarantee for private depositors of various commercial banks. Metro tokens increase from 2 to 3 roubles.

2 September

The Federal Securities Market Commission challenges the validity of the Central Bank bonds to be issued under Central Bank Regulation No. 52-P and 53-P of 28 August 1998.

2 September

The Central Bank details further its plan to guarantee private depositors.

3 September

The Moscow City Arbitration Court accepts the application for bankruptcy of Tokobank.

4 September

Inkombank, the third largest bank in Russia, is placed under temporary Central Bank administration.

4 September

Central Bank Directive No. 344-U "On Suspending Payments by Residents to Non-Residents on Forward Currency Contracts" Prohibits payments under forward currency contracts during the moratorium.

7 September

Rouble exchange rate rumored from 20 to 40:$1. Sergei Dubinin resigns as head of Central Bank. Chernomyrdin rejected by the Duma for the second time, 273 to 138. Moscow District Court suspends temporary administration of Inkombank. Long lines appear at gas stations in anticipation of price increases.

8 September

Gasoline prices rise from 2.6 to 3.7 roubles per liter, much less than anticipated. A Moscow court voids the Central Bank's takeover of Inkombank. The rouble "stabilizes" at about 20:$1, down from 6.2 23 days earlier.

9 September

Joint Ministry of Finance and Central Bank Clarification on the "Procedure for the Redemption of State Short-term Zero-coupon Bonds and Federal Loan Bonds with Fixed and Floating Coupon with Maturity up to 31 December 1999 and Issued into Circulation Prior to 17 August 1998". The clarification extends until 18 September 1998 (inclusive) the date for holders of GKOs/OFZs maturing from 17 August 1998 to 3 September 1998 to apply to acquire new state bonds.

9 September

Rouble jumps to 14:$1. Yeltsin talks to or about Lebed, Stroyev, Primakov and Maslyukov. The Association of Russian Banks files with the Supreme Court of the Russian Federation a claim to invalidate various recently adopted legal acts.

10 September

Rouble falls to 9:$1 as exporters are required to sell half their earnings and Gazprom dumps dollars on the market. Chernomyrdin withdraws and Yeltsin nominates Yevgeny Primakov as Prime Minister. Inkombank agrees to let the Government have 50% + 1 share, but not 75% + 1.

11 September

No roubles available on the street. Primakov approved 317 to 63. He names Yuri Maslyukov as First Deputy Prime Minister for Economic Policy (Communist Duma member and former head of Gosplan) and Igor Ivanov to replace himself as Foreign Minister. At Yeltsin's request, the Duma names Victor Geraschenko, who held the job during 1992-94 when hyperinflation raged and was called by Jeffrey Sachs "the world's worst Central Banker", to again head the Central Bank. Rosbank formed by Uneximbank, Most Bank, and Bank Menatep. Renaissance cancels merger with MFK. MFK expected to join Rosbank.

15 September

Rouble remains artificially low. The Moscow Times speculates it is because forward currency contracts can be settled more advantageously. The Central Bank suspends the temporary administration of Inkombank until the 4 September Order of a Moscow Court is overturned.

16 September

Alexander Shokhin, regarded as a centrist and supporter of production sharing, is appointed Deputy Prime Minister for Finance. The rouble falls 22% from 9.61: $1 to 12.45: $1.

17 September

Two more relative moderates, Vladimir Ryzhkov (Our Home is Russia Duma Speaker) and Vladimir Bulgak (Deputy PM for Science and Technology under Chernomyrdin) join the Cabinet, as Deputy Prime Ministers for social policy and industry and communications, respectively. The rouble continues its collapse. Shokhin states that there will be a week's delay in debt restructuring. News reports indicate 160,000 professionals lost their jobs in Moscow since 17 August.

18 September

Regulation 55-P is repealed by Directive No. 352-u. The rouble hits 14.6: $1 following the Central Bank's statement that it will print new money to increase liquidity in Russia's failing banks. Late Friday and into Saturday the Central Bank buys GKOs from major Russian banks, which are supposed to use these proceeds to pay their debts. Banks which cannot repay their debts are theoretically to be closed. An estimated 3.2 billion in roubles $256 million] added to money supply. Foreign holders of $11 billion in GKOs (now worth $5 billion at current exchange rate) not allowed to participate. Vladimir Ryzhkov refuses the thankless post of Deputy Prime Minister for Social Issues, claiming inexperience (age 32). Vadim Gustov, Governor of Leningrad Oblast accepted a position as First Deputy Prime Minister for Regional Affairs.

21 September

Central Bank does not permit currency exchange to open. Official rate remains at 16.38. Gennady Kulik, Agrarian Party (ally of communists) named Deputy Prime Minister for Agriculture.

22 September

Valentina Matviyenko, Ambassador to Greece, nominated to be Deputy Prime Minister for Social Affairs. Finance and State Tax Service still open.

23 September

MGTS (Moscow City Telephone) pays $9mm in interest due on Eurobonds issued March '98.

24 September

PM Primakov states that the 17 August announcements were not authorized by the President, not well thought out and resulted in chaos. Shokhin claims that Russia "joined" the Paris Club on unprofitable terms and demands negotiations on offsets. The Paris Club refuses to renegotiate Russia's debt while talks between IMF and Russia continue. Shokhin wants IMF funds agreed to in July and negotiations on changing the agreement since both the IMF and Russia are equally responsible for the present situation. Geraschenko warns that "excessively greedy and stubborn foreign banks" may get nothing. "I do not want to scare the West with statements about a default on Russia's foreign debts, but Western financial organizations should be loyal." Western institutions want to wait until year end to see how things develop, giving Russia few options. Sale of Rosneft cancelled again. Alexander Livshits reportedly nominated as Finance Minster, with Sergei Generalov reappointed Fuel and Energy Minister, along with Sergei Frank at Transport. Law on Bankruptcy of Financial Institutions passed second and third readings in Duma.

25 September

Final Cabinet appointments: Nikolai Aksenenko, Minister for Railways; Pavel Krashennikov, Minister of Justice; Boris Pastukhov, Minister for CIS Cooperation; Ramazan Abdulatipov, Minister for Nationalities; Dmitri Gabunia, Minister of Trade and Industry; Andrei Shapovaliants, Minister of Economy; Mikhael Kirpichnikov, Minister for Science & Technology. Mikhail Zadornov reappointed as Minister of Finance. Official ruble rate will be 15.6099. Sergei Dubinin becomes Deputy Chairman of Gazprom Bank. Shokhin resigns after ten days, citing objections to reappointment of Zadornov as Minister of Finance. Others say he resigned because IMF has refused September tranche of July rescue package.

25 September

Lehman attaches $117 million in London accounts of Unexim and Inkombank. Inkombank owes Lehman $87 million in forward contracts. Deadline for GKO choices again postponed. Central Bank states another 10.6 billion roubles ($668mm) was exchanged with commercial banks. Debts to regional tax agencies were paid by banks withdrawing rubles from their reserves, not by the CB purchasing GKO's. 1.96 billion roubles taken from reserves. September 18 took 3.3 billion roubles. Dmitry Vasiliev announces he will resign if the Government follows the policies of Geraschenko and Zadornov.

28 September

Boris Fyodorov fired by PM as head of State Tax Service; Viktor Khristenko, Deputy PM fired as well. Farit Gazizullin, reappointed as State Property Minister Yeltsin states he has not accepted Vasiliev's resignation as head of Federal Commission on the securities markets. Rouble rate set at 15.88

29 September

Rouble rate set at 15.99. Lehman attaches SBS Agro accounts in London in a dispute over a "repo" transaction. Georgy Boos, Duma Deputy, named head of tax service. Press revealed Dubinin's salary of $240,000 per year or 1,258,113,518 rubles, the same as the salaries of 210 Duma deputies.

30 September

Uneximbank has frozen the accounts of Lehman in Moscow at Uneximbank and other Moscow banks. Luzhkov in Blackpool for Tony Blair's Labor Party conference says he is considering running for President if there are no qualified candidates. He supports a "left-center" mix of a market economy with social concerns.

Conclusion

Banking theory, or, more generally, the theory of financial intermediation, studies why intermediaries and financial markets co-exist in the modern economic world, and what role financial intermediaries play in economic development and growth. A particular topic of the theory of financial intermediation is the optimal design of banking regulation, aimed at promoting the efficiency of the intermediation and at preventing banking crises or reducing the damage of financial crises. Three pillars of the regulation are of a great importance with respect to the handling of financial crises: competition regulation, insurance regulation (including insolvency resolutions), and prudential supervision. In this dissertation, I paid major attention to the first two.

With regard to insolvency resolutions, the choice in favor of either the liquidation of insolvent banks or the bailout of them, may lead to a decrease in intermediatory efficiency compared to financial markets. Both choices create limited liability of banks, which results in excessively high deposit interest rates in a competitive banking sector. In a monopolistic case, the deposit interest rate is too low compared to the expected rate of return in the financial markets, and this may lead to welfare distortions in economy. A standard result of the theory is also the moral hazard effect of the bailout policy, which is out of the focus of this dissertation. The moral hazard argument is a usual justification of the commitment of a regulator to the liquidation of insolvent banks. As I show in Chapter 2, the disadvantages of bailouts may be reduced through an internalization of bailout costs by banks.

A kind of a trade off between liquidation and bailout is seen since 1990-s in the "constructive ambiguity" in the regulation. I argue in Chapter 2 that the ambiguity with regard to insolvency resolutions may be harmful for the economy, and the banking sector may fail to be so efficient in the allocation of funds, as financial markets are. The ambiguity may create asymmetry in beliefs of depositors and bankers with the first relying on the liquidation of insolvent banks, and the second hoping for a bailout. Still, there is a space for "constructive ambiguity" in a stochastic bailout rule. If the probability of bailouts is announced, the asymmetry in beliefs between depositors and bankers disappears, and the banking system may provide the same allocation of funds as financial markets do. However, the stochastic (uncertain) bailout rule may still lead to an allocative inefficiency of the banking sector compared to financial markets, if depositors internalize the bailout costs and exhibit cautionary behavior. Shifting the burden of the bailout to the next generations of depositors could be a possible solution of this problem.

Considering overlapping generations of depositors allows one to study another regulatory phenomenon, a forbearance of regulators in bailing out insolvent banks or liquidating them. To study this phenomenon, I extended the model from Chapter 2 into a dynamic setting in Chapter 3. An advantage of forbearance is the internalization of liquidation costs by banks. It may also be viewed as a destruction of the limited liability, and it thus prevents, in particular, excessive interest rates in a competitive banking sector. At the same time, intergenerational workout incentives eliminate internalization of bailout costs by depositors. This suggests that an uncertainty in timing of bailouts, which is associated with the regulatory forbearance, may be optimal since it may promote the efficiency of financial intermediation.

However, the above result refers to a comparative statics analysis of the equilibrium allocations achieved in the bank-based and the market-based economy in a particular period. The sustainability of the result depends on the stability of the equilbrium. To study the efficience of the banking sector in dynamics, I suggest an overlapping generations general equilibrium model in Chapter 4, which establishes a dynamic equivalence between the intermediated economy and the market-based one. If the equilibrium is disturbed in a way which does not involve underpayment of agents, then both the intermediated economy and the market-based one converge to the stationary equilibrium and follow the same development path to it.

If, however, the system is disturbed through an exogenous shock, which leaves creditors underpaid, then the intermediated economy may follow a development path, which differs from the one of the market-based economy. In particular, in presence of intergenerational workout incentives and regulatory forbearance, the shock may create deficits in the banking system, which grow with time and may lead to a collapse (bankruptcy) of the banking system as a whole. The insolvency resolutions pillar of the regulation provides with a possibility to either liquidate insolvent banks or to bail them out. In the first case, the intermediated economy would replicate the market-based economy. However, the liquidation should not be anticipated by the banks, otherwise inefficiency may arise through the effects discussed in Chapter 2 and 3 and summarized above. Bailing the banks out through a liquidity assistance in the form of loans, may postpone the collapse if such loans are costless. Otherwise, costly loans lead to accumulation of deficits in a competitive banking system, which is bankrupt in a finite number of periods. The same happens, if the regulator follows a policy of forbearance, and the banks effectively borrow from the future generations at the deposit interest rate to finance current deficits.

In order to prevent the collapse, the bailout policy should be combined with the competition regulation. Obviously, a monopolist bank is less vulnerable to shocks, since the monopolist rent allows it to cover the deficits occured as an impact of the shock. The regulation of the competitive structure may include interventions of the regulator in the decision-making by banks. If the liquidity assistance is combined with such interventions, it is possible to create an interest rate margin, which allows competitive banks to cover deficits à la monopolist bank. Another type of the competition regulation is the interest rate regulation, in particular the regulation of the deposit interest rate. An introduction of a deposit rate ceiling also creates an interest rate margin, which prevents the collapse. Finally, subsidization may be also viewed as a distortion of the competitive outcome, which allows to prevent the bankruptcy of the banking system. These complements to the bailout policy are studied in Chapter 5.

Chapter 6 provides a comparison of the three banking crises in the 1990s: in Russia, in Sweden, and in Japan. These three banking crises have similarities: they are shock-triggered, and the economies are in large bank-based. The Swedish banking crisis was the quickest one, with the complete recovery of the economy during two years. The interventions of the Swedish banking regulators combined deposit guarantees, liquidity assistance and operative control of banks by the regulatory authorities; according to the model from Chapter 5, this approach ensures the quickest recovery of the economy. The Japanese banking crisis has been continuing over a decade. The regulatory policy in Japan combines deposit guarantees and forbearance with regard to the liquidation of insolvent banks; according to the model, this may lead to a postponement of a recovery, if both credit and deposit real interest rates are zero, which is exactly the case in Japan. The policy of low interest rates prevents the collapse through deficit accumulation, but does not provide conditions for a positive interest rate margin which is needed for the recovery.

The case of Russia combines regulatory forbearance during almost a year after the triggering shock, a delayed liquidity assistance and no deposit insurance. In the absence of any deposit guarantees, a promt reaction to the panic was initially the freezing of deposits and later on the transfer of them to the state-controlled Sberbank. This action prevented (or at least reduced) the deposit outflow, which is not considered in the model due to the assumption of the existence of deposit insurance. Such an action of banking regulators prevented the collapse but also contributed to the postponement of the recovery. The liquidity assistance neither was restrictive nor did it presume a regulatory control over the banks under bailout, contrary to the Swedish case. Finally, no regulatory measure was introduced to create a positive profit margin for banks. As the model predicts, the situation deteriorated in the aftermath of the shock until the regulatory policy started to change in about a year after the crisis begin. The welfare consequences of the crisis were smoothened by the fact that the population diversified their wealth and used U.S. dollars as a cushion against macroeconomic risks.

The theoretical considerations and the examples of the banking crises suggest that the banking system may provide an intertemporal smoothing of macroeconomic shocks, but this requires a proper regulatory system. A market-based economy concentrates the burden of a macroeconomic shock on the generation of the period of the shock. The issue of the intertemporal smoothing seems to be more relevant for developing, emerging and transitory economies; moreover, these economies seem to be more vulnerable to the shocks, as the discussion in Chapter 5 suggests. Therefore, it may be important for emerging economies to concentrate efforts on the creation of sound banking systems, as they contribute to financial and macroeconomic stability to a higher degree than financial markets do.

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